DECEMBER, 1951
No. 178



# ASTM Bulletin

NEWS—New Publications; Standardization Conference; Metals Powders at Spring Meeting; 50th Anniversary Symposiums and Notes; Gillett Memorial Lecture.

PAPERS—Preserving Our Historic Documents; Fine Aggregate Tests (2); Creep Tests of Plastics; Cleaning Paint Test Panels; Protective Coatings for Plastics; Floor Tile Resins; Index to 1951 ASTM BULLETINS.

American Society for Testing Materials

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# ASTM BULLETIN

*Published by*
AMERICAN SOCIETY for TESTING MATERIALS

1902—50th Anniversary Meeting—1952

## *This Issue Contains*



NEWS ABOUT THE SOCIETY AND ITS COMMITTEES:



MISCELLANEOUS NEWS NOTES:



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DECEMBER—1951

No. 178


# How to get best results with Glass Volumetric Apparatus... *described in this new book*

As a service to scientific and clinical laboratories, Kimble Glass after months of development and research has prepared a new and informative book, "The Care and Handling of Glass Volumetric Apparatus."

Some of the subjects of vital interest to laboratories are: a short history and explanation of the metric system of weights and measures; how to clean apparatus; how to read the meniscus; how to fill and empty flasks, cylinders, burettes, pipettes; gravimetric calibration; calculation of volume of a glass vessel from apparent weight of liquid; volumetric calibration.

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# ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

TELEPHONE—Rittenhouse 6-5315 | R. E. Hess, Editor | CABLE ADDRESS—TESTING, Philadelphia

R. J. Painter, Associate Editor

Number 178 DECEMBER, 1951

# ASTM Lists New Publications

## Standards Supplements, Paper and Paperboard Monograph, Textile Appearance Boards, and Several 1951 Compilations of Standards

Important new publications are announced to ASTM members and those in all phases of industry who are concerned with the developing and establishing of standards and the promotion of authoritative technical knowledge of materials.

These publications which can now be obtained at ASTM Headquarters are listed below with a brief description of contents, background, and prices.

## 1951 Standards Supplements Being Completed

Work has been under way for some time on the 1951 Supplements to the Book of Standards, and it is expected distribution of certain of the Supplement Parts can begin early in December. The following approximate schedule of completion dates may be of interest to many of the members. There are so many factors influencing the printing and distribution that no exact dates can be supplied.

1951 Supplement to Book of Standards

(Approximate Dates of Availability)

Part 1—Ferrous Metals—December–January

Part 2—Non-Ferrous Metals—December–January

Part 3—Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, Soils—January–February

Part 4—Paint, Naval Stores, Wood, Adhesives, Paper, Shipping Containers—January

Part 5—Textiles, Soap, Fuels, Petroleum, Aromatic Hydrocarbons, Water—December

Part 6—Electrical Insulation, Plastics, Rubber—December

These books, which are an essential part of the Book of Standards, not only provide material published for the first time, but of equal importance, include the many revised specifications and tests. They will range from 250 to 450 pages each.

Members will receive automatically the Parts which have been requested on their membership. A special circular soliciting orders for the Supplements from purchasers of the big Book was mailed in November.

The list price for each Supplement is \$3.50; the price to members for *extra* Supplements, \$2.75 each.

## 1951 ASTM Standards on Coal and Coke

This compilation brings together again in ready reference form the various ASTM test methods, specifications, and definitions for coal and coke, and the standard specifications for classification of coal by rank and grade.

Sponsored by ASTM Committee D-5 in response to widespread demand for such a publication, this volume dated September, 1951, covers sampling, chemical analysis, size, dustiness, grindability, etc. Eight proposed methods are included as information for the purpose of soliciting comments. These proposed methods involve expansion, pressure during coking, plastic properties, carbonization pressure, and aglutinating value.

Committee D-5 is actively engaged in further improvement of these methods and specifications and in the development of additional tests, particularly those for the plasticity and swelling of coal, the ignitability of coal and coke, and methods of sampling coal.

The 151-page book sells for \$2.25; to ASTM members for \$1.70.

## New ASTM Cotton Yarn Appearance Standards

An improved series of photographs constituting the Cotton Yarn Appearance Standards has recently become available. The complete set of five parts, with four photographs on each, now embody the improved standards.

The photographs ($5\frac{1}{2}$ by 10 in. each) for each group are mounted on a board $27\frac{1}{2}$ by 15 in. A very substantial composition board is used, and photographs are well mounted.

The grouping of yarn numbers covered by the five boards is as follows:

| | | |
|---|---|---|
| 3.0s | to | 7.0s |
| 7.0s | to | 16.5s |
| 16.5s | to | 32.0s |
| 32.0s | to | 65.0s |
| 65.0s | to | 125.0s |

The new boards are available at \$6 each; a set of five boards, \$27.50, postage prepaid.

To those who have the previously issued standards and who return the old boards to ASTM Headquarters, a special price for the new boards of \$3.50 each, all five, \$16.50, will be made.

ASTM Committee D-13 on Textile Materials would like to promote the use of the latest improved standards to replace those formerly in use.

*Are you interested in:* Publications—p.5; Committee Week and Annual Meeting—pp. 8, 9; ASA Annual Meeting—p. 11; District Meetings—p. 18; Fall Committee Meetings—p. 21; Aggregate Tests—pp. 35, 44; Polyethylene Polymers—p. 47; Floor Tile Resins—p. 62; Yearly BULLETIN Index—p. 65.

# Greatly Enlarged and Revised Report on Paper and Paperboard

## (Characteristics, Nomenclature, and Significance of Tests)

It has been felt for some time that a revised and expanded edition of the 1944 Monograph on Paper and Paperboard was necessary, both to bring the existing material up to date, and to add new material to the book. The report was originally undertaken as a project of Subcommittee II on Significance of Test Methods, of ASTM Committee D-6 on Paper and Paper Products, to provide an authoritative discussion of the characteristics of different types of paper; the significance of tests applied to them; and also, paper terms and nomenclature.

The monograph provides expert and critical discussion of the significance of the more commonly used tests, and defines terms, nomenclature, and properties of paper related to these tests. It is provided as a service to those who may contact the field of paper infrequently, or who may be familiar with but a limited portion of the field. It will be helpful in orienting the reader in the subject of paper evaluation so that he may ascertain in general the tests that may be employed to gain the knowledge desired relative to the utility of a specific paper for a particular use.

Many portions of the book will be of interest to the technologists and other experts working directly in the paper industry.

In addition to Lewis S. Reid, Metropolitan Life Insurance Co., and past-chairman of Committee D-6, the editor of this publication, the following prominent individuals cooperated in the preparation of the material:

- H. A. Anderson, Western Electric Co.
- R. D. Bonney, Congoleum-Nairn, Inc.
- M. S. Kantrovitz, Government Printing Office
- W. B. Lincoln, Jr., Inland Container Corp.
- C. E. Peterson, Riegel Paper Corp.
- B. W. Scribner, National Bureau of Standards
- P. L. Staats, General Electric Co.
- P. F. Wehmer, Electrical Testing Laboratories, Inc.
- W. R. Willets, Titanium Pigment Corp.

To these men and to Roger C. Griffin, Clark C. Heritage, and others who prepared the first edition should go full credit for this publication.

The 1951 Paper Monograph is divided into four parts. *Part I* provides a general introduction including the objective of the monograph; paper as a simple structure; essential steps in paper manufacture; paper as a complex structure; the nature of paper properties, etc. *Part II*, The Action of Water on Paper and Its Significance covers action of water vapor and liquid water. *Part III* covers Definitions of Terms, Nomenclature, and Properties of Various Classes of Paper and Paperboard including discussion of bond and writing papers, envelope papers, printing papers, paper towels and toilet tissues, condenser paper, bristols, paperboard, building papers, wrapping papers, etc.

*Part IV* covers Tests Applied to Paper and Paperboards and Their Significance, with sections on acidity and pH; air permeability and resistance to passage of air; Alpha-, Beta-, and Gamma-Cellulose; ash (mineral content); basis weight paper and paperboard; blocking resistance and bursting strength; color; copper number; folding endurance; flammability; foreign material; kerosine number of roofing and flooring felt; moisture content; opacity; paraffin content of waxed paper; pentosans; scuff resistance test; puncture and stiffness test; flat crush test; sampling paper and paper products; stretch; bonding strength; tearing strength; thickness and density; water resistance; etc.

A helpful part of the monograph is a list of the ASTM and TAPPI methods of testing paper and an extensive subject index is included.

The 140-page book sells for $2.50 to nonmembers and $1.85 to members.

# Articles on Fatigue

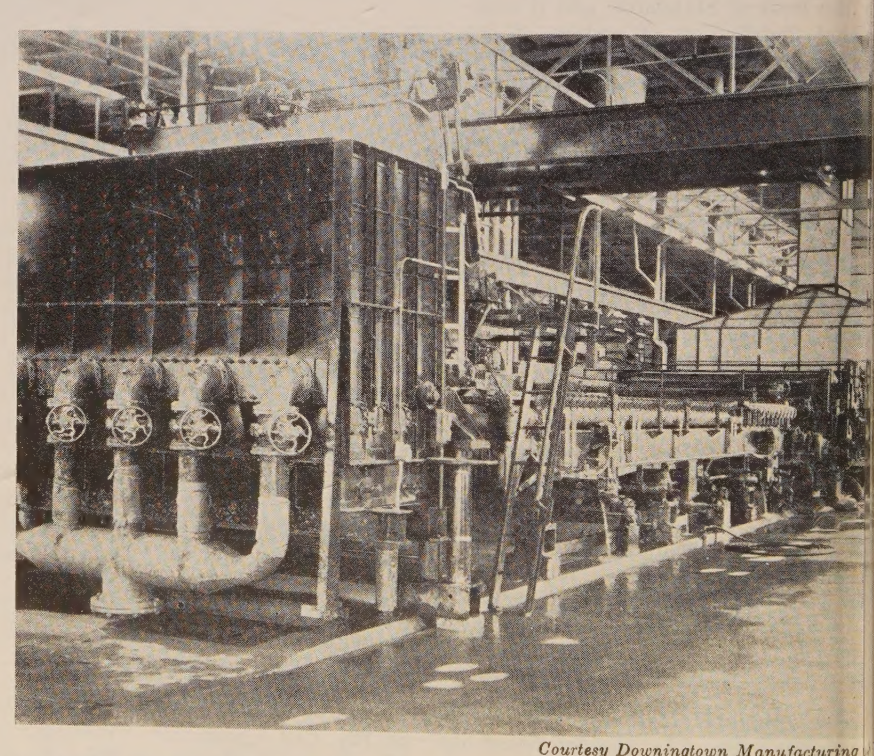
Committee E-9 on F[illegible]tigue, at the suggestion of its Surve[illegible] Subcommittee, has issued a 28-pa[illegible] (duplicated) pamphlet giving referenc[illegible] to articles published in 1950 dealing wi[illegible] fatigue. Brief abstracts of the mo[illegible] than 125 articles have been include[illegible] when these were readily available. T[illegible] list is not exhaustive but may be su[illegible]ficiently extensive to be of interest [illegible] those concerned with this field.

Both the nature and format of th[illegible] list are experimental. References a[illegible] generally so arranged that sheets c[illegible] readily be cut apart for filing accordi[illegible] to any desired plan. If there is su[illegible]ficient interest in lists such as this, [illegible] may be possible to provide addition[illegible] lists periodically—for example, eve[illegible] six months.

Comments and suggestions concerni[illegible] the value and format of this list wou[illegible] be appreciated. Correspondence shou[illegible] be addressed to: Professor T. J. Dola[illegible] Chairman, Survey Subcommittee [illegible] ASTM Committee E-9, 321B Talb[illegible] Laboratory, University of Illinois, U[illegible]bana, Ill.

This first list containing the referenc[illegible] to 1950 articles is a trial publication a[illegible] subsequent editions will depend up[illegible] the sales and other indications of a [illegible]sire for subsequent similar publicatio[illegible]

Copies can be obtained from AST[illegible] Headquarters at $1.50 each.



*Courtesy Downingtown Manufacturing* [illegible]

Illustrating the headbox, fourdrinier part and screen, and press part—indicative [illegible] the complicated but efficient and fast-working machinery that produces paper.

## 1951 Standards on Petroleum Products

This special compilation of ASTM specifications, tests, and definitions covering petroleum products and lubricants is one of the most widely distributed ASTM publications. This is indicative of the intense interest in evaluating the properties and quality of a wide range of petroleum products, and it also indicates the value of the book, which provides in compact, ready form the widely used ASTM standards in this field. Methods of test for knock rating of engine fuels, however, are issued in a special volume and are not included in this compilation; and several recently approved standards for measuring and sampling petroleum are also not included, these appearing in the ASTM Manual of Measuring and Sampling Petroleum and Its Products.

Sponsored by ASTM Committee D-2 on Petroleum Products and Lubricants, this book has been issued annually since 1927, each edition giving the material in its latest approved form. There is considerable new material in each issue.

The 1951 edition gives in their latest approved form over 100 test methods, numerous specifications, lists of definitions of terms relating to petroleum and to rheological properties of matter; and recommended practice for designating significant places in specified limiting values.

In addition, several appendices are included covering the following: Penetration of Lubricating Greases Worked More than 60 Strokes; Measurement of Density and Specific Gravity of Liquids to the Fifth Place (Bingham Pycnometer Method); Saponification Number of Petroleum Products (Para-Xylenol Blue Color-Indicator Method); Oil Content of Petroleum Waxes; Kinematic Viscosity; Determinining Motor and Research Octane Numbers of Small Samples; and Determing Motor and Research Octane Numbers of Small Samples (Multi-Pipet System).

Also included in this compilation are Recommendations on the form of ASTM Methods of Test for Petroleum Products and Lubricants; List of Proposed Methods Prepared by Committee D-2 and Published as Information Prior to 1950; Regulations Governing the Committee and other information on Committee D-2; and the latest D-2 annual report.

This 804-page book, in heavy paper or cloth cover, is $5.75 a copy; $4.40 to members, and can be obtained at lower prices if purchased in quantity. For cloth, add 65 cents to these prices.

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## 1951 ASTM Standards on Textile Materials

The 1951 edition of this compilation includes in their latest form 88 specifications, test methods, and tolerances developed by ASTM Committee D-13 on Textile Materials. Considerable other related material is included.

Standards cover: asbestos, bast and leaf fibers, cotton, glass textiles, rayon and silk, wool, pile fabrics (carpets), felt, and general fibers; fabrics, yarns, threads, and cordage. Also identification, qualitative, and quantitative analysis; and resistance to insect pests and microorganisms. General test methods cover testing machines, humidity, and interlaboratory testing. There are tests of stretch and snag resistance of hosiery. Extensive sections give photomicrographs of common textile fibers and of defects in woven fabrics; a glossary of textile terms, and terms relating to hand of fabrics.

Included in this compilation for the first time are the very comprehensive tentative methods of test for resistance to abrasion of textile fabrics, with numerous illustration.

Appendices cover basic properties of textile fibers, a psychrometric table for relative humidity, and a yarn number conversion table. Also, proposed methods of test cover evaluation of properties related to the hand of soft-finished woven fabrics, accelerated aging of textiles, estimating the clean wool content in wool in the grease, and fire-retardant properties of treated felt. Two other appendices cover proposed recommended practices for calculating number of tests to be specified in determining average quality of a textile material and for designation of yarn construction.

A convenient table of contents is included (by subject and ASTM serial designation) and an index of methods of test.

The 612-page book, with heavy paper cover, sells for $5 a copy.

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## Standards on Bituminous Materials for Highway Construction, Waterproofing, and Roofing—1951

The second edition of the "Bituminous" compilation brings up to date the various ASTM standard and tentative specifications, test methods, recommended practices, and definitions of terms pertaining to bituminous materials used in highway construction and in waterproofing and roofing. Sponsored jointly by Committee D-4 on Road and Paving Materials and Committee D-8 on Bituminous Waterproofing Materials, this book includes those standards covering creosote materials which are under the jurisdiction of Committee D-7 on Wood but of direct interest to the highway construction field.

The present revision, aggregating 344 pages, contains 98 standards in their latest approved form. These comprise a large group of specifications for various types of bituminous materials used in highway construction, as well as a group giving quality requirements for waterproofing and roofing materials—shingles, asphalts, felts, coal-tar pitch, etc., creosote specifications, and an extensive series of tests; also definitions of terms relating to materials for roads, and timber preservatives. Additions since the 1948 edition cover methods of testing asphalt-base and bituminous emulsions for use as protective coatings, bitumen content of paving mixtures by centrifuge, cohesion and compressive strength and specific gravity of bituminous mixtures, and plastic flow of fine-aggregate bituminous mixtures. New specifications relate to granular mineral surfacing for asphalt roofing and shingles.

This book is available to members at $2.50, the list price being $3.25.

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***1902***

***FIFTIETH ANNIVERSARY MEETING***

***TENTH EXHIBIT OF TESTING APPARATUS AND LABORATORY SUPPLIES • Photographic Exhibit***

***June 23-27, 1952 • Hotels Statler and New Yorker • New York City***

***1952***

# Symposium on Testing Metal Powders and Metal Powder Products to Feature 1952 Spring Meeting

## Meeting in Cleveland, March 5, During ASTM Committee Week, March 3–7, 1952

An interesting Symposium on Testing Metal Powders and Metal Powder Products, with a number of authoritative technical papers, is to feature the 1952 spring meeting of the Society at the Hotel Statler, Cleveland, on Wednesday, March 5. This symposium, some details of which are given below, is being sponsored by ASTM Committee B-9.

The Spring Meeting will be held during ASTM Committee Week extending from March 3 to 7, inclusive. During this week, there will be several hundred meetings of the various ASTM technical committees that are participating. An advance list of the committees that have thus far indicated they will meet is given below. For further information, see the January Bulletin. Also, a direct mail communication will go to all ASTM members giving information on hotel reservations, a detailed main committee schedule, etc., early in January.

The symposium is being developed by technical men of Committee B-9 representing the leading consumers and producers of these products. While many symposiums have been held on the scientific and technical aspects of powder metallurgy, this is believed to be the first symposium which is specifically concerned with methods of testing. Powder metallurgy as a production method has made rapid progress during the last few years and the work of Committee B-9 has resulted in a number of standard specifications and tests. The proposed papers for this symposium are given below. However, it should be pointed out that these titles are only tentative but they will give an excellent idea as to the nature of the symposium.

- Methods and Devices for Testing Sintered Iron Rotating Bands, by John D. Dale, Frankford Arsenal.
- Permeability and Strength of Porous Stainless Steel Compacts, by F. V. Lenel and O. W. Reen, Rensselaer Polytechnic Institute.
- Survey of Methods for Testing Cemented Carbide Compositions, by J. C. Redmond and A. D. Stevens, Kennametal, Inc.
- Particle Size Measurement of Metal Powders by the Air Elutriation Method, by P. S. Roller of Hyattsville, Md.
- Particle Size Determination in Metal Powders, by R. P. Seelig, American Electro Metal Corp.
- Quality Control on Structural Parts Made from Metal Powders, by T. J. Snodgrass and W. A. Hinkle, General Electric Co.

### ASTM Committee Week

Those committees which have thus far signified their intent to hold meetings during Committee Week are indicated below. Further details will be furnished all members later. Instituted many years ago, Committee Week provides an opportunity for a large number of the committee members to attend in a concentrated period, meetings of the numerous groups with which they are affiliated, thus conserving time and expense.

This year there is added emphasis on Committee Week because a number of the technical groups are attempting to handle much of their technical work, both standardization and research in March, rather than to develop an extensive subcommittee schedule for the Fiftieth Anniversary Annual Meeting of the Society in New York the week of June 23.

The following are scheduled to meet:

- A-3 on Cast Iron
- A-7 on Malleable-Iron Castings
- A-10 on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys
- B-6 on Die-Cast Metals and Alloys
- B-7 on Light Metals and Alloys, Ca[illegible] and Wrought
- B-8 on Electrodeposited Metallic Coatings
- B-9 on Metal Powders and Metal Powder Products
- C-1 on Cementitious, Ceramic, Concrete, and Masonry Materials
- C-7 on Lime
- C-8 on Refractories
- C-16 on Thermal Insulating Materials
- D-1 on Paint, Varnish, Lacquer, and Related Products
- D-4 on Road and Paving Materials
- D-5 on Coal and Coke
- D-16 on Industrial Aromatic Hydrocarbons
- D-19 on Industrial Water
- E-1 on Methods of Testing (Subcommittees)
- E-9 on Fatigue

### Cleveland District Plans President's Reception and Dinner

The Cleveland District Council, the host group for the Spring Meeting, is planning an informal reception for President Fuller including a subscription dinner preceded by a complimentary cocktail hour. At the dinner President Fuller will give a portion of his talk "Solving Problems in Materials" and there will be other interesting features. Further details will be sent directly to the members.

## Why Am I an ASTM'er?

In the files at ASTM Headquarters are hundreds of letters which embody statements by our members on why they value ASTM. Many of these communications are copies of letters used by our members in following up membership invitations. Recently a compilation of a few of the statements has been made for the new Administrative Committee on Member, Industry and Public Relations (MIPR). A few of the "testimonials" will be used from time to time in the ASTM Bulletin.

*From a Midwest Member—A Technical Leader in His Field—*

. . . I have been a member of ASTM for many years, working principally in the metals groups. I would welcome the opportunity to give you any information at my command.

The Society is a consumer-producer group. Its strength and authority rest largely on this fact. Its standards represent mutual accomplishment based upon mutual understanding and mutual effort. As a result they have been adopted by many engineering societies, federal and state agencies, and various consumer and producer groups.

Participation in committee work not only helps develop many useful contacts in one's industry, but it also gives one insight and knowledge not easily acquired in one's daily work.

It was my privilege to be on the Society's Administrative Committee on Research for several years, and thus to get an over-all picture of this effort. Beside its own committee-sponsored work it has "tie-ins" or contacts with a large segment of the research activities in other agencies. Committee members therefore get a wider range of information than might be suspected.

## lotes on Fiftieth Anniversary Meeting, June 23–27, 1952, Hotels tatler and New Yorker, New York City; Progress on Most Extensive echnical Program, Apparatus, and Photographic Exhibits; Special eatures

THE various groups re- onsible for features of the Society's ftieth Anniversary Meeting to be held e week of June 23–27, 1952, New York ty, are making excellent progress.

The Administrative Committee on ıpers and Publications working rough a Special Program Committee completing details of the more than 35 chnical sessions which will be neces- ry to provide for the presentation of a zen technical symposiums and numer- s other papers and reports. A wide nge of technical subjects will be cov- ed as noted in the October ASTM JLLETIN. Details of certain sessions e given below, and subsequent BUL- TINS will provide further details of her symposiums.

The New York Committee on Ar- ngements, headed by Past-President R. Townsend, Bell Telephone Labora- ries, Inc., has begun operations with rious subcommittees developing their ans. A complete list of the officers and bcommittee chairmen appeared on ge 12 of the October BULLETIN.

Contacts have been made for an out- nding speaker for the special dinner ssion. Details of financing features of e meeting are nearing completion. e rules and regulations for the Photo- aphic Exhibit are being studied, and ıer activities are under way. As indi- ed elsewhere in this BULLETIN, many the leading manufacturers and dis- butors of testing apparatus and oratory supplies have reserved space the Tenth ASTM Exhibit which will in progress throughout the week of ne 23 in the Statler's ballroom.

There is no question that this week l be a very significant one for all se concerned with the field of ma- ials. The whole affair will be a well- ınded one with due cognizance of the iety's Fiftieth Anniversary and the lespread importance of its contribu- ns for half a century.

*ın Now to Be There for the Entire Week!*

## ?52 Exhibit to Be Held in atler Ballroom

SITUATED just above the zzanine, New York's Statler ballroom deally located and appointed for the h ASTM Exhibit of Testing Equip- nt and Laboratory Supplies. The el, headquarters for many of next r's ASTM functions, is centrally located at Seventh Ave. and 34th St., and is convenient to train, subway, and bus.

Nearly every mail brings one or more new applications for space in the Exhibit. Regular visitors at ASTM Exhibits will be glad to know that a number of former exhibitors have already signed up for the New York show. A number of local apparatus manufacturers, previously deterred by shipping distances, have expressed a desire to take part. Although it is perhaps too early to say, every evidence at hand suggests that the 1952 Exhibit will be one of the best ever presented under ASTM auspices.

Certainly those attending the ASTM 50th Anniversary celebration will find much to interest them in the variety of apparatus displayed.

## 1952 Annual Meeting Symposiums

NUMEROUS symposiums are being arranged for the very extensive technical program planned for the 1952 Annual Meeting and some of these have developed to the extent that we are listing below the papers to be included therein. At this time, it should be recognized that some of these titles are tentative; nevertheless an excellent idea of the nature of the symposium can be obtained from these titles.

### Symposium on Test Methods for Process Control in Ceramic Whitewares

*(Sponsored by Committee C-21 on Ceramic Whitewares)*

The Status and the Importance of Terminology in Ceramic Whitewares—Arthur S. Watts, Ohio State University

Possibilities for Adapting Research Tools for Process Control Evaluations—John H. Koenig, Rutgers University

Report on Round-Robin Investigation of Modulus of Rupture Tests—Rolland Roup, Globe-Union, Inc.

Report on Round-Robin Investigation on Methods of Evaluating Subsieve Particle Sizes of Non-Plastic Materials—C. J. Koenig, Ohio State University

Evaluation of the Critical Properties of Clays,—T. A. Klinefelter U. S. Bureau of Mines

Report on Committee Investigation of Process Control in the Whitewares Industry—C. H. Commons, Locke, Inc.

### Symposium on Direct Shear Testing of Soils

*(Sponsored by Committee D-18 on Soils for Engineering Purposes)*

Controlled Volume Direct Shear Test—Donald Taylor, Massachusetts Institute of Technology

Determining the Shear Strength of Certain Clay Minerals by Direct Shear Test—E. J. Kilcawley, Rensselaer Polytechnic Institute

The Strength of Gravel in Direct Shear—R. G. Hennes, University of Washington

The Use of Direct Shear Tests in Earth Work Projects Under Construction—R. R. Proctor, Los Angeles Department of Water and Power

The Use of Direct Shear Tests in Engineering Practice—F. J. Converse, University of California

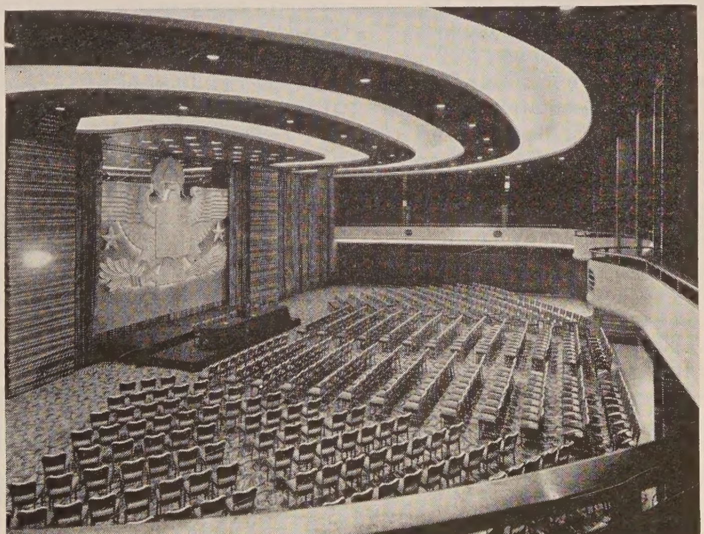
Use of Direct Shear Tests in Highway Design—E. S. Barber and C. L. Sawyer, Bureau of Public Roads

It is also planned to have a paper on "The Importance of Controlling Conditions in Direct Shear Testing."

### Symposium on Exchange Phenomena in Soils

*(Sponsored by Committee D-18 on Soils for Engineering Purposes)*

Keynote paper covering review of the problem, summarizing present knowledge, presenting basic concepts of soils mechanics properties in relation to exchange phe-



nomena, and outlining needed research—Ralph E. Grim

Cation Exchange Capacity in Loess and Its Relation to Engineering Properties—Donald T. Davidson, Iowa State College

Job Experience with Exchange Phenomena Involving Inorganic and Organic Ions—Hans F. Winterkorn, Princeton University

Surface-Chemical Properties of Clay Minerals and Soils as Revealed by Recent Experimental and Theoretical Developments in Electro-Osmosis—Gerhard Schmid, Technische Hochschule Stuttgart, and Hans F. Winterkorn, Princeton University

There will also probably be papers on "Cation Exchanges in Soils and the Relation of Various Cations Upon Atterberg Limits" and "Ion Exchange in Soil Stabilization" and "Absorption and Adsorption of Water by Clays, Micas, and Soils."

### Symposium on Continuous Water Analysis

(*Sponsored by Committee D-19 on Industrial Water*)

Continuous Sampling of Industrial Water—M. F. Madarasz, Ford Motor Co.

Some Practical Aspects of the Measurement of pH, Electrical Conductivity and Oxidation-Reduction Potential of Industrial Water—Robert Rosenthal, Industrial Instruments, Inc.

Discussion on Continuous Analysis of Industrial Waste Water—A. E. Griffin, Wallace & Tiernan Co., Inc.

Measurement of Color, Turbidity, Hardness and Silica in Industrial Waters—F. C. Staats, Hercules Powder Co.

The Continuous Measurement of Dissolved Gases in Water—J. K. Rummel, S. T. Powell

### Symposium on Determination of Elastic Constants

(*Sponsored by Committee E-1 on Methods of Testing*)

Report on ASTM Task Group for Determination of Elastic Constants—Walter Ramberg, National Bureau of Standards

Elastic Constants of Steels at Elevated Temperatures—G. V. Smith, F. Garofalo, and P. R. Malenock, United States Steel Co.

Dynamic Methods for Determining the Elastic Modulus and Its Temperature Variation in Metals—M. E. Fine, Bell Telephone Laboratories, Inc.

An Evaluation of Several Static and Dynamic Methods for Determining Elastic Moduli—J. T. Richards, The Beryllium Corp.

There will also be a paper on "Determination of Elastic Constants of Non-Metallic Materials."

### Symposium on Conditioning and Weathering

(*Sponsored by Committee E-1 on Methods of Testing*)

General Introduction

Fundamentals of Atmospheric Elements—Benarthur C. Haynes, United States Weather Bureau

Textiles—Robert H. Brown, Parks-Cramer Co.

Paper—William H. Willets, Titanium Pigment Corp.

Adhesives and Organic Plastics—Frank Reinhart, National Bureau of Standards and Lucius Gilman, Picatinny Arsenal

Organic Coatings—Edward J. Dunn, Jr., National Lead Co.

Metallic Coatings—Clarence H. Sample, International Nickel Co.

Large Scale Conditioning—A. E. Stacey, Jr., Carrier Corp.

Small Scale Conditioning—Kenneth N. Mathes, General Electric Co.

Test Fences—Kenneth G. Compton, Bell Telephone Laboratories

Accelerated Weathering Devices—Roscoe H. Sawyer, Devoe & Reynolds Co.

The following symposiums will also be held at the 1952 Annual Meeting and titles of papers in these symposiums will be given in another issue of the ASTM Bulletin.

Tin
Durability of Concrete
Fretting Corrosion
Testing Adhesives for Durability and Permanence
Plastics
Light Microscopy
Effects of Notches and Metallurgical Changes on Strength and Ductility of Metals at Elevated Temperatures
Session on Paint
Session on Fatigue

## Offers of Papers for 1952

The Administrative Committee on Papers and Publications will meet early in February to consider the papers to be published by the Society in 1952 and to develop the program for the 1952 Annual Meeting to be held in New York City, June 23–27. All those who have in mind offering papers for presentation at the Annual Meeting and publication by the Society should send these offers to Society Headquarters *no later than January 15.* All offers should be accompanied by a Summary which should make clear the intended scope of the paper and indicate features that, in the opinion of the author, will justify its inclusion in the Annual Meeting program and publication by the Society. Suitable blanks to be used in transmitting the desired information will be sent promptly on request.

## Earmark Photographs for 1952 Photographic Exhibit

### Section on Photomicrography to Include Metallography and Electron Microscopy

All members and committee members, and those affiliated with company members, who are concerned with photography may wish to be earmarking prints that might be suitable for display in the 1952 Photographic Exhibit—one of the features of the Fiftieth Anniversary Meeting at the Hotel Statler in New York City during the week of June 23.

A New York committee headed by Myron Park Davis is being appointed and will decide on the general rules and regulations. However, at this time it can be stated that the general theme will be along the lines of previous exhibits, that is, a general photographic section devoted to the field of materials, testing, and research. It is probable the committee will suggest photographs featuring apparatus, instruments, standards, and related items. The committee also will unquestionably welcome pictures showing unique or unusual applications of materials and the human element or personal factors.

#### Section on Photomicrography

ASTM Committee E-4 on Metallography will again sponsor a section on photomicrography. The past few exhibits have featured a large number of displays in this field which include micrography, electron microscopy, and related photomicrography. A special committee, headed by Sidney W. Poole, Republic Steel Corp., has been appointed in Committee E-4 to develop the rules for this section of the exhibit, working with the New York group.

The committee plans to stimulate interest of technical students in the exhibit, and contacts are to be made with technical and engineering faculty men responsible for courses in this field.

Further information will be given in the ASTM Bulletin and by direct mail (about February or March, 1952) to the members.

# Standardization Conference Stresses Value and Significance of Standards

## ASA Annual Meeting Highlights "Strengthening America"

MANY of the country's eading executive and technical people articipating in the Second National tandardization Conference held in conunction with the Annual Meeting of the merican Standards Association in New York in October testified to the high alue of standardization activities. The neeting theme was "Strengthening merica Through Standards."

Two leaders in standardization activiies were honored—former President Herbert Hoover receiving the Howard Coonley Medal, and P. G. Agnew, for nany years secretary of the American tandards Association, receiving the rst award of the ASA Standards Medal. t was fitting that Mr. Hoover should eceive the Coonley Medal, because as nuch as any man he has by his foreight, energy, and prestige emphasized o America the important role of standrdization in our national industrial fe.

In accepting the award as presented y Robert E. Wilson, Chairman of the Board, Standard Oil Co. (Indiana), Mr. Hoover made a short, pertinent aceptance address, excerpts of which apear on this page.

Among the well-attended sessions at he meeting were those devoted to inustrial standards for defense producion, a materials conservation forum, nd the ASA company member conerence, which held the attention of a arge audience throughout. One session f particular interest was sponsored by he Committee on Standardization of he National Association of Purchasing gents on the subject "Standards for Purchasing and How to Use Them." There is a separate article in this BULLETIN relating to this session includng an extended abstract of a pertinent ddress by J. H. Foote, Vice-President, Commonwealth Services, Inc., former ASTM officer, and extremely active in ASTM, currently serving as a member f the Administrative Committee on tandards.

### General Notes

Some further reference may be made n subsequent BULLETINS to various apers presented at the ASA meeting. What follow are simply brief notes which n the editors' opinion would be of inerest to the ASTM membership.

In the opening address at the meeting ASA President Thomas D. Jolly, Vice-President, Aluminum Company of America, forcibly stated:

"The decisive factor that led to military victory in World Wars I and II was American industrial production. Many varied elements went to make up that production, but standardization was certainly its dominant characteristic. . . .

"The effectiveness of any army today depends on the production machine behind it. The effectiveness of the machine, in turn, depends on the techniques of standardization—on such basic engineering techniques as continuous straight-line assembly, maximum use of standard components, and minimum changes in type.

"Two conditions must be met if we are to develop and use the standards our economy now requires and will need in the future.

"One is a growing, expanding national standardization movement supported by private industry and carried out on the principles of voluntary cooperation by industry. There is a place for government standards, and a place for the government in standards work; but as Senator Ralph Flanders said in an article on standards in the *Atlantic Monthly* last January:[1] 'Standards are now built into the very structure of American industry. . . . If you control an industry's standards, you control that industry lock, stock, and ledger. . . . No government planner knows enough to write the standards for the rest of American industry and all other American people. . . . Creative dynamic standards are not composed on the higher levels and handed down by decree and proclamation. They are formulated by the volun-

[1] An extended abstract of this pertinent article appeared in the May issue, ASTM BULLETIN, pp. 26–28.

### Excerpts from Remarks by Herbert Hoover in Accepting the Howard Coonley Award

"... THE increase in our living standards and comfort has received an enormous contribution from these related ideas of standards, of simplifications, and specifications.

"They are at the base of all mass production. They make possible more continuous employment by manufacture for stock instead of dependence upon immediate and specialized orders. They have made it possible to conduct this fabulous productive machine with the least amount of spare parts and inventories in the hands of the consumer industries. They have sharpened competition. They have cheapened the cost of production in millions of directions. Thus they have been a factor in our rising living standards. They have enabled thousands of different articles to be placed within the reach of everybody. They do not impose uniformity on the individual, because they make available to him an infinite variety of additions to his living.

"This technology and its blessings reach unheralded into every household, not into industry alone. Before you set to work, the housewife had to shop for special electric lamps that would fit her sockets, for special needles for her sewing machine. At one time she had to trim the bedstead or the springs or the mattress to make them fit with each other. But now they all fit, no matter what the breed. The workman at one time had to find a bolt of the same maker before he could screw a nut on it and had to search among a hundred different diameters. Now the half-inch nuts screw onto all the half-inch bolts, and there are but two score of different diameters instead of two hundred. And the common man should be grateful that the three-score sizes of automobile wheels and tires have been replaced by about half a dozen standard sizes.

"And the sum total of all these ideas has contributed to making thousands of machines which have lifted the burden from the backs of men and women.

"This work of your Association has brought another invaluable accomplishment. Only a few of the literally tens of thousands of standardizations or simplifications have been imposed by law. The vast numbers of them have been the result of spontaneous, voluntary, yet organized cooperation within highly individualized industry. To secure general acceptance of any one of them has been tedious at times. But their adoption has been playing a real part in the creation of the cooperation so vital among a free people.

"Certainly it is true that the objects of organized society are to assure justice, freedom, respect for the dignity of men and the improvement and security in living. And to this you continue to make a valuable contribution."

tary agreement of all groups concerned. They must be worked out by the people themselves.'

"The second condition is that government and industry must respond to the absolute national need at this time for cooperation in the field of standards. The impact of science, technology, and perpetual international crisis upon our institutions has been so enormous that it is no longer possible to keep the functions of government and the functions of industry in separate watertight compartments on the old theory that, like oil and water, they cannot and should not mix. In standards, especially, government and industry must put aside their distrust and rivalry and work together toward a common end.

"The government has plenty of brains in its offices; but it does not have *all* the brains and sometimes it does not have the *best* brains. Government people, moreover, sometimes lack adequate information, particularly at the day-to-day working level. Some of them even believe that the use of a purely industrial specification in government procurement is in some way illegal or at least morally wrong. Thus they may not know that a perfectly adequate standard product exists; or if they know, they may not care; or they may actually object to using it.

"Government procurement men want the best possible product. They will get it—and get it quickly and cheaply—if they cooperate with industry in drawing up the standards for it—if they draw on the high technical talents of the men who design, manufacture, distribute, and sell the nation's goods. They cannot get it if they are content to order industry what to make and how to make it, with inadequate consideration for industry experience and facilities as set forth in industry's own standards.

"Standardization is a movement which must be promoted—I use the word in its broadest and best sense—continually promoted if American industry is to operate at its highest possible level.

"Someone has said that there is nothing so irresistible as an idea which has found its proper time. I believe that voluntary standardization is such an idea. I believe that the standards idea has found its time, and in the hard, uncertain years ahead of us will be one of our greatest assets in winning technical advancement, prosperity, and security for our people."

Concerning industrial standards for defense production, R. C. Sogge, Executive Department, General Electric Co. noted that:

"The experience in each war has demonstrated that standards are of major importance in national defense. . . . Human nature being what it is, it is understandable that there are some in military who show an attitude that the Government should dictate to industry, and, likewise there are some in industry who feel that Government should take what industry makes without change. The development of proper industrial standards is a cooperative activity, and barriers that have prevented most effective cooperation should be studied and overcome. . . . The development and adoption of common industrial standards present a great opportunity for both the military and industry. A real effort should be made to promote plans for working together to our mutual advantage."

# Standards for Purchasing and How to Use Them

## Panel Stresses Value of Standards in Purchasing

At a session of the National Standardization Conference held in October, four speakers stressed important aspects of standards, particularly their value to the purchasing profession. Sponsored by the Committee on Standards of the National Association of Purchasing Agents, the session was arranged by Vincent deP. Goubeau, Vice-President in Charge of Materials, Radio Corp. of America.

The program was as follows:

*Standardization as Applied to Mass Production*—J. S. Davey, Assistant General Sales Manager, Russell, Burdsall and Ward Bolt and Nut Co. (also representing Industrial Fasteners Inst.)

*How Electrical Standards Aid Purchasing*—A. E. Pringle II, Vice-President, Pringle Electrical Manufacturing Co. (also representing National Electrical Manufacturers Assn.)

*How ASTM Operates*—R. J. Painter, Assistant Secretary, American Society for Testing Materials.

*Putting Standards Into Action*—J. H. Foote, Vice-President, Commonwealth Services, Inc.

Short notes on some of these papers follow, with a more extended abstract of the address by Mr. Foote.

### Standards and Mass Production

Active in standards work for many years and widely known in the industry, Mr. Davey, who participates in both ASA and ASTM committee projects, built up an impressive case for the significant progress made in standardization in his industry. This industry, with more than 125 manufacturers whose main product is threaded fasteners, cuts up somewhat more than 2 per cent of the steel produced in this country; this year about 2 million tons. It cuts each ton into an average of 50,000 pieces per ton, which in a day's production is about 250,000,000 pieces. In a bolt, there are some 32 dimensions to be held, many to very close tolerances; a nut has about 18 such dimensions.

Mr. Davey discussed briefly the history of standardization in fastenings which started well over 100 years ago, with screw threads for muskets. In 1868, the Navy recommended the adoption of the Sellers form of thread, but widespread standardization really dates from the work of the National Screw Thread Commission established by Herbert Hoover in 1918. The American Engineering Standards Committee, forerunner of ASA, in 1922 started work on dimensions of bolt threads and nuts which worked miracles in better production.

"As important as the dimensions," Mr. Davey said," are the mechanical and physical properties. These, too, must be standardized and the ASTM has seen to it that these important elements are taken care of. If the engineer designs a product, he must either know the properties of standard materials or specify his own. Specifying his own makes a product just as special in every respect. Even before industry has had need for higher physical properties or additional tests, ASTM has foreseen and written standards to cover such requirements.

"It should be understood that the standards of industry are not frozen. New needs and uses, improved materials and processes, and general technical advance made additions and changes of standards a constant activity. There has been since the last World War a great deal of activity by all the sponsoring groups and the results, many of which are just about ready for publication, show tremendous advancements."

A case history in the plow bolt field was startling. At one time his company made 386 different heads, 15[illegible] head styles of a $\frac{3}{8}$ in. diameter No. [illegible] head alone. The angle of the head varied from 38 to 114 deg.

The first plow bolt standard brought out as American Standard in 1928 narrowed the ten head styles to four and it set up standard angles. Just recently, a new one, ASA No. B18.9-1950 has been adopted.

"I can quote the benefits of plow bolt standardization to our company. After the 1927 standard, we finally got our plow bolt equipment up to 35 per cent production efficiency. Since the new standard has been adopted, we have been able to get it up to 75 per cent and are still gaining."

Referring to standards, Mr. Davey noted that

". . . under more normal times, we can make large economical runs for our stock. We can run our plants on a planned production basis. We can hold our costs to a minimum and balance out our work cycles. We know the product is salable; it is to a standard. The user gets the advantage of the large runs even though he only buys the quantities needed. He can carry a minimum of inventory, knowing that plenty of products required by him are just around the corner. He can exercise his judgment and knowledge of purchasing. He has confidence that the product will do the job; it is to a standard.

"Standardization is the very essence of competition. It gives the buyer the freedom to select his source of supply based on the fundamental principle of service, quality, and price. It gives the buyer the safeguard of more than one source of supply. It is the common ground on which we can do business as the standard nomenclature is understood by everyone. It eliminates the costly mistakes of wrong products and rejects. It is hard to visualize how our competitive system could possibly go on without it. Standardization is not only one of the factors, it is an essential for mass production."

**William C. Newberg, President, Dodge Division, Chrysler Corp., on "Industrial Standards for Defense Production"**

"This job of standardization is a never-ending one. We only make a dent in the problem when a whole new field is opened up. . . . As we increase the area of our knowledge, we also widen the borders of our ignorance. But as big and important as the job of standardization is, those who are specializing in that job must be on constant guard against pursuing standardization for its own sake. A standard at best represents the ceiling point of development attained at the time of adoption. If thereafter everything different is to be thrown out because it does not conform, the inevitable result will be to stifle initiative and stop progress. . . . There must be common sense to your standards so that the vital standards are not impaired by dissipating your best talents and equipment over unnecessary operations."

### Electrical Standards—Aid Purchasing

A LEADER IN standards work in his industry, A. E. Pringle II, Vice-President, Pringle Electrical Manufacturing Co., gave a brief historical background showing the impressive strides made by his industry in developing needed standards. The National Electrical Manufacturers Association currently carries on intensive programs. Citing the significance of a standard electric current all over this country, he also noted that today a motor can be specified by its rating and frame size, and a choice selected from bids of different manufacturers, with the knowledge that the one chosen will fit the application for which the purchase is made. This is also true of the wiring devices and construction materials used in an electrical installation.

Mr. Pringle cited the tremendous significance of the National Electrical Codes

". . . where the interests of the manufacturer, the contractor, the electric light company, and the inspector are all amalgamated to give the user in the home and in the factory a product which has been standardized from the generating plant to the lamp in his living room or office, and to see that he and his property are reasonably protected from hazard and fire. Note also that this standardization enables the manufacturer to sell his products anywhere within the jurisdiction of these codes.

"Can we not apply the same principle to aid you in your jurisdiction, namely, purchasing? When you have electrical equipment to buy or a contract to let, see that your specification recognizes the appropriate American Standards or those of NEMA, AIEE, or Underwriters' Laboratories and thereby make it approved in your jurisdiction. When you buy on this basis, whether for one plant or dozens, you know that your purchase will meet nationally recognized standards and can be serviced by trained technicians in the locality in which it will be installed. Part of your job is to keep the machinery in your plants operating; you help your maintenance men by ordering standard equipment for which spare parts are available."

# Putting Standards Into Action[1]

## By J. H. Foote[2]

PURCHASING agents are dynamic people. Their concern with standardization of materials lies primarily in the benefits to be achieved.

There is a popular misconception in many quarters that standardization means putting everybody's ideas into a hat, shaking it, and coming up with an average. There could be no more false assumption. Standards will not work that way. The problem is much more complicated, and much more meaningful. We might well inquire therefore—what constitutes a "good" standard: what are its benefits and what will make it of interest to purchasing agents?

*Four* benefits from a "good" standard are obviously just what the purchasing agent might order: First, *lower costs;* second, *greater comparative value;* third, *quicker deliveries,* and fourth, *repetitive availability*—can you duplicate it some day or is it just a special bargain? These are only four of the many benefits.

Because putting standardization into action involves the exciting of interest and the meriting of respect, the first thing we should do is to examine the elemental requirements of good standards.

### Good Standards

*First,* a good standard should include the viewpoints, desires, and limitations of all interests. The organization of a national standardizing body is aimed primarily at bringing together *all* of the interests involved; this point is stressed in the operations of the ASTM. An ASA sectional committee or ASTM technical committee represents the whole gamut of interests—everyone concerned has a voice. So, to be of interest to the purchasing agent, a standard should represent the viewpoints, desires, and limitations of all interests.

*Second,* a good standard should select varieties, to reduce the number of items available and so effect economies. But in reducing varieties it should do so with a careful appraisal of the demand.

*Third,* a good standard should be the product of collaboration by those best informed in the field.

These are three important and elemental requirements of a good standard. What qualities should a good standard have to be attractive and without which it fails to merit the full enthusiasm and interest of purchasing agents?

### Qualities of a Standard

For one thing, a good standard should have the *quality of necessity.* It should supply a genuine need. There are few

[1] Presented during a session sponsored by the Committee on Standardization of the National Association of Purchasing Agents at the Second National Standardization Conference held in conjunction with the 33rd Annual Meeting of the American Standards Association, October 22–24, New York City.

[2] Vice-President, Commonwealth Services, Inc., Jackson, Mich.

national standards that lack this quality. Any standard that gets through ASTM or ASA procedures must fill a need or it will not have made the grade. These procedures are such that they filter, buffet, and almost guarantee a needful standard.

Another quality of the good standard is that of *comprehensiveness.* It must fill the bill—do the job. It must comprehend the problems of both the producer and the consumer. It must encompass the various needs and provide an adequate variety of types and sizes, simplifying wherever possible.

[At this point Mr. Foote detailed an example relating to culvert pipe. A state highway department has concentrated on four types of pipe in various sizes, thus meeting the needs for the "little" culvert with light load, ASTM C 14; for use on heavier traveled roads, C 75; and finally for big trunk highways and rugged use, C 76 (two grades).]

Here is a fine example of the simplification and opportunity for reduction in cost available in a good series of standards. Just suppose that every one of the 48 states had a Highway Department that devised its own specifications. There might be at least 48 types of pipe, dimensions, testing methods, and other requirements. But instead we have this outstanding simplification, achieved not by bringing everything down to *one* sole type of product, but by producing a *comprehensive* job of simplification.

Besides necessity and comprehensiveness, a good standard also requires the *quality of virility.* It must and should be kept up to date. This means constant examination, re-examination, and revision. The national standardizing bodies all have rigorous procedures to insure virility. In ASTM standards and tentatives must be reviewed and certified periodically. The ASA has a similar procedure. Other bodies have means of assuring that a standard doesn't grow whiskers and begin to represent a false value.

A fourth more subtle but certainly fundamental quality is that of *integrity.* Any national standard should have unimpeachable character. And, of course, the character of a standard is not likely to be higher than that of its formulators. The pattern of organization of standardizing committees and their procedures in the ASA, the ASTM, and other such bodies provides for checks and balances and reviews and approvals to insure this integrity in the standards they produce. The formulators of the standards are so chosen and designated that the character of the standard is of the highest order. How do we go about selecting and applying standards—these tools that are designed to be used to our advantage? What is the procedure for getting the most out of what the market offers in standardization? I suggest consideration of five points.

*First,* make sure you are informed as to the standards available in your field. Engineers and purchasing agents should collaborate in studying lists of available standards. You should scan the bulletins of the standardizing bodies, the publications of technical societies and trade associations, and news on standards in the trade press.

Next, be informed of the *real* requirements of the consumer interests. Engineers, constructors, designers, and operators—all must collaborate. A remarkable lack of accurate information exists with respect to *real* requirements. Frequently something is a standard just because it has been in the specification for as long as anybody can remember. The purchasing agent cannot always make the decision, but he most certainly can and should ask questions.

Then you should select, adapt, a[illegible] *make use* of available standards. Y[illegible] may find it helpful to set up a liais[illegible] committee within your organizati[illegible] Purchasing agents may be very help[illegible] in suggesting adaptation of standar[illegible] Many standards make provision for [illegible]tions or modification in one respect [illegible] another. The ASTM standards are [illegible] of selective options. These not o[illegible] have great utility, but they focus [illegible] attention of other purchasers who n[illegible] options on a selected list of th[illegible] thereby reducing the number of va[illegible]eties.

A fourth point is important in t[illegible] business of making use of standar[illegible] You should correspond with natio[illegible] standardizing organizations. Get yo[illegible]self on mailing lists; get into co[illegible]spondence with all the organizations a[illegible] find the committee or group that [illegible] interested in and working on your ty[illegible] of problem or product. Then you [illegible] express your needs and your viewpoi[illegible]

Finally, you and your compan[illegible] engineers should collaborate as much [illegible] you possibly can with national sta[illegible]ardizing organizations in their wo[illegible] Tremendous dividends will ensue fr[illegible] collaborating with others in their fi[illegible]

Show standardizing committees [illegible] are interested and that you endorse a[illegible] support what they are trying to do [illegible] you. Let them have lists of the pe[illegible] in your organization to whom they [illegible] go for information. And let your [illegible] organization know that you are c[illegible]cerned with the preparation and use[illegible] good standards. Everyone in your co[illegible]pany should know that you, as a p[illegible]chasing agent, are concerned w[illegible] standardization as a factor in effec[illegible] economies. Cooperation in standard[illegible]tion is profitable. Let us be dyna[illegible] about it.

## Standards Promoted by Publication in Business Journals

Considerable effort is made to publicize and promote the use of the standard specifications and test methods developed by the Society through its technical committees. In certain phases of this work the Society, down through the years, has had close cooperation on the part of many editors of trade and technical magazines. This includes the use of news articles and also complete reprinting of specifications or tests pertinent to the field covered by the respective journal.

For example, a two-part article in the October and November, 1951, issues of *Foundry* magazine, gives the complete ASTM Tentative Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 F (A 278 – 51 T). *Foundry* always includes a data sheet, and from time to time, the editors give widespread publicity to ASTM standards by using them as a basis for this particular article.

Many other technical journals have reprinted ASTM specifications or tests; thus acquainting a large number of readers in their specific fields with our standards. The Society welcomes this use, feeling that there is no more important medium to advance the Society's purposes than through our most excellent trade and technical press.

## Men

*Its results are born in the laboratory, [illegible]*
*nurtured in the pilot plant,*
*and brought to maturity with manufactu[illegible]*
*But research ideas are conceived in [illegible]*
*minds of men, and it is men who must b[illegible]*
*these ideas to fruition.*
*America's scientists and engineers [illegible]*
*human beings gifted with prac[illegible]*
*imagination.*
*They are a vital national resource,*
*for we must win much of our future sec[illegible]*
*and abundance in the laboratory.*
*New products, new processes, and*
*weapons don't just happen.*
*Men must invent and develop them.*

—from the Introduction by H. A. L[illegible] to the 1951 Annual Report of the Arm[illegible] Research Foundation of the Illinois In[illegible]tute of Technology.

## evisions in Standards for Austenitic Pipe and Still Tubes

On the recommendation Committees A-1 on Steel and A-10 on on-Chromium, Iron-Chromium-Nickel ıd Related Alloys, revisions have been pproved in the Tentative Specifications for Seamless and Welded Austeni- Steel Pipe (A 312), and similar anges made, but as tentative revisions, the Standard Specifications for Seamss Austenitic Chromium-Nickel Steel ill Tubes for Refinery Service (A 271). As approved by the Administrative Committee on Standards, the revisions reduce the number of tension tests that had previously been required. The committees responsible pointed out that when the specifications were new with the tensile properties unproved, there was every justification to establish a high frequency of tests, but with years of service and thousands of tests a reduction in the number could now be justified. Furthermore, these materials are used largely at elevated temperatures, and the tensile properties cannot be used directly for design purposes. The tension test serves in conjunction with chemical analysis and manipulation tests to insure that the material is not patently defective. The compositions covered by these specifications, properly annealed as demonstrated by the flattening and flaring tests, can hardly fail to meet the tensile requirements.

These revised specifications will be published in the 1951 Supplement to Part 1 of the Book of Standards and also in the Steel Piping Materials compilation to be issued early next year.

## REA Emergency Recommendations

Acting at the suggestion of e National Production Authority, the nerican Railway Engineering Assn. has ued in the interest of conservation of itical materials the first of what may be a ries of emergency recommendations. ıis action was taken through the Emerncy Committee of the AREA Board of rection which was created as the first of e emergency committees. The four ditional Emergency Technical Comttees deal with Track Problems; Strucral Problems; Fuel, Water, and Sanitary oblems; and Ties and Wood Preservam. These committees parallel similar ıergency groups set up during World ar II which promulgated a series of prosions which continued in effect until the ose of hostilities.

This first recommendation adopted as an ening gesture on the part of the associan in cooperation with the defense moization effort of the committee reads as lows:

"Pursuant to the needs of the National Defense Mobilization Effort of the United States and friendly countries, especially for ferrous and nonferrous metals in short or tight supply, it is recommended that, for the duration of the present Emergency, or until revoked by action of the Association, the users of AREA specifications and recommended practices as presented in this Manual, minimize the requirements of critical materials called for, by the adoption of modifications and substitutions, to the fullest extent possible, consistent with the establishment and maintenance of the essential services of the railroads. In no case, however, does this recommendation suggest or imply the adoption of changes from existing specifications or recommended practices which would jeopardize either the safety or the adequacy of railway service."

## Complete List of Emergency Alternate Standards

Listed below are the Emergency Alternate Standards approved by the Administrative Committee on Standards as this Bulletin goes to press. The issue of the Bulletin in which the alternate provisions were printed in full is given for convenient reference.

| Designation | | Covers | |
|---|---|---|---|
| EA | 26 | Steel Tires | October, 1951 |
| EA | 167 | Corrosion-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip | October, 1951 |
| EA | 199 | Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes | September, 1951 |
| EA | 200 | Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service | September, 1951 |
| EA | 213 | Seamless Alloy-Steel Boiler and Superheater Tubes (Tentative) | September, 1951 |
| EA | 240 | Corrosion-Resisting Chromium and Chromium-Nickel Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels | October, 1951 |
| EA | 249 | Welded Alloy-Steel Boiler and Superheater Tubes | September, 1951 |
| EA | 268 | Seamless and Welded Ferritic Stainless Steel Tubing for General Service | September, 1951 |
| EA | 269 | Seamless and Welded Austenitic Stainless Steel Tubing for General Service | October, 1951 |
| EA | 270 | Seamless and Welded Austenitic Stainless Steel Sanitary Tubing | September, 1951 |
| EA | 271 | Seamless Austenitic Chromium-Nickel Steel Still Tubes for Refinery Service | October, 1951 |
| EA | 276 | Hot-Rolled and Cold-Finished Corrosion-Resisting Steel Bars (Tentative) | October, 1951 |
| EA | 296 | Corrosion-Resistant Iron-Chromium and Iron-Chromium-Nickel Alloy Castings for General Application (Tentative) | October, 1951 |
| EA | 312 | Seamless and Welded Austenitic Stainless Steel Pipe (Tentative) | October, 1951 |
| EA | 314 | Corrosion-Resisting Steel Billets and Bars for Reforging (Tentative) | October, 1951 |
| EA | 329 | Heat-Treated Steel Tires (Tentative) | October, 1951 |
| ED | 69 | Friction Tape for General Use for Electrical Purposes (Tentative) | September, 1951 |
| ED | 119 | Rubber Insulating Tape (Tentative) | September, 1951 |

## ckaging and Materials Handling gineers Hears about ASTM

At the Sixth Packaging and aterials Handling Short Course, of the riety of Industrial Packaging and Maials Handling Engineers in Cleveland, io, October 3, W. B. Lincoln, Jr., Techal Manager, Inland Container Corp., esented a most interesting paper on STM—The Work of the Committee on sting Methods."

In his interesting talk, Mr. Lincoln, who is very active in the work of ASTM Committee D-6 on Paper and Paper Products (Chairman of its Subcommittee IV on Container Board) and in Committee D-10 on Shipping Containers, outlined his conception of the professional man, noted ASTM contributions to the profession, and then explained in down-to-earth fashion the workings of ASTM and, in particular, its technical committees.

There is a limited supply at Headquarters of the paper presented by Mr. Lincoln and a copy will be sent as long as the supply lasts.

From time to time ASTM members, particularly those who have been active in committees, describe the Society and appropriate phases of its work before members of various technical and trade groups. The efforts of the members in this respect are appreciated by the Society officers. The Staff will be glad to supply pertinent information to any of our members who have in mind presenting such talks.

ASTM Bulletin

DECEMBER 1951

NO. 178

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

## H. W. Gillett Memorial Lecture Established

THE American Society for Testing Materials together with Battelle Memorial Institute is sponsoring the establishment of an annual H. W. Gillett Memorial Lecture. The purpose of the lecture is to commemorate Horace W. Gillett who was one of America's leading technologists, the first Director of Batelle in Columbus, Ohio, and for many years an active worker in ASTM.

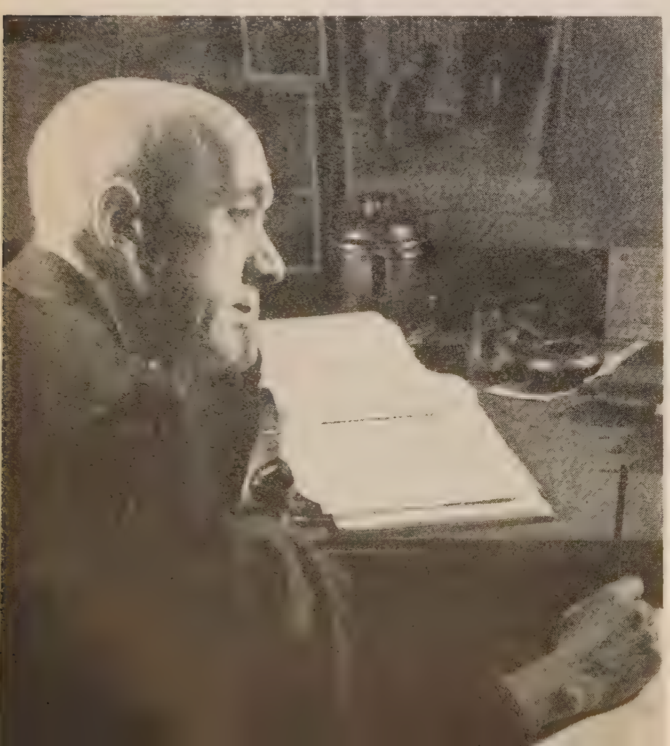
The memorial lecture will be delivered annually at a meeting of the Society, the first to be given at ASTM's 50th Anniversary Meeting in New York City during the week of June 23, 1952. The lecturer, who will be selected annually through a committee appointed by the ASTM Board of Directors, will cover a subject pertaining to the development, testing, evaluation, and application of metals. Dr. Gillett was intensely interested in these fields, particularly in a critical evaluation of metals and alloys. Further provisions in the agreement between ASTM and the Institute provide for an honorarium, and the publication and dissemination of the lecture.

Dr. Gillett in his accomplishments as scientist, engineer, metallurgist, scholar, and writer; in his work as Director of Battelle Memorial Institute; in his service to the American Society for Testing Materials; and by his qualities as a man, achieved a place of high honor and distinction among his fellow engineers and in the metallurgical industries.

A member of ASTM for over 25 years, he served on many of its technical committees, notably in the field of metals, contributing numerous outstanding technical papers and reports to the ASTM publications. He was a most able writer and couched his material in a unique and effective style.

Prior to his death in March, 1950, Dr. Gillett was an active member of many technical and scientific groups and had received numerous honors and awards.

The committee appointed by the Board of Directors to develop with representatives of Battelle the rules governing the lecture included the following: R. L. Templin, Aluminum Company of America; J. W. Bolton, The Lunkenheimer Co.; and N. L. Mochel, Westinghouse Electric Corp. Representing Battelle were Messrs. H. C. Cross, J. H. Jackson, and H. ... Pray.



An informal photograph of Dr. Gillett with the ever-present curved-stem pipe in evidence, and in the background, a picture of a dog. Dr. Gillett was a great lover of dogs and an ardent sportsman—in fact, he died on his way back north from a southern hunting trip.

Future committees, which will select the lecture, will include a representative of the Board, one from the Administrative Committee on Papers and Publications, and one from Battelle.

Announcement will be made shortly of the first lecturer.

## "First" District Meetings in Leading Cities —A Trend

A NOTABLE trend in recent District meetings is the holding of technical sessions in industrial centers other than the large cities which are the main center of District work. The Administrative Committee on District Activities has advocated that the District Councils, from time to time, hold meetings at some of the larger industrial centers in their respective areas. Western New York-Ontario, as a regular practice holds technical meetings at various intervals in Rochester, Buffalo, Toronto and other Ontario cities. New England has had excellent meetings in Worcester, Providence, and Hartford, in addition to Boston, and as noted in this BULLETIN, the Ohio Valley District held a first ASTM meeting in Louisville, K... (Others have been held in Columbus and Dayton.) The Chicago District is ... sponsor a meeting in Milwaukee jointly with the Milwaukee Section of The American Society of Mechanical Engineers at which President Fuller will speak.

These meetings make it possible ... members in those cities, who may not get to national meetings, to meet the District Officers, representatives of ... Staff, and very frequently, the President or other national officers. With ... exception, the meetings have been stimulating and very successful.

Much credit is due the District Councilors who have "spark-plugged" the meetings and whose names are noted ... the condensed news accounts of District activities given in the BULLETIN.

Within the past three years, ASTM District or informal meetings have been held for the first time in the following cities:

| | |
|---|---|
| Minneapolis-St. Paul | Hartford, Conn. |
| Portland, Ore. | Niagara Falls, ... |
| Dallas, Tex. | St. Catharines, ... |
| Houston, Tex. | White Oak (Silver Spring), Md. |
| New Orleans, La. | Columbus, Ohio |
| Birmingham, Ala. | Louisville, Ky. |
| Worcester, Mass. | Allentown, Pa. |
| Providence, R. I. | |

## Schedule of ASTM Meetings

| Date | Group | Place |
|---|---|---|
| December 4 | Committee E-1 on Methods of Testing | Philadelphia, Pa. |
| December 5–6 | Committee D-21 on Wax Polishes and Related Material | Washington, D. C. |
| December 6 | Committee C-11 on Gypsum | Washington, D. C. |
| December 18 | Philadelphia District | Philadelphia, Pa. |
| 1952 | | |
| January 22 | Board of Directors | Philadelphia, Pa. |
| January 28–31 | Committee A-1 on Steel | Philadelphia, Pa. |
| February 5 | Philadelphia District | Philadelphia, Pa. |
| March 3 | Pittsburgh District | Pittsburgh, Pa. |
| March 3–7 | 1952 Spring Meeting and Committee Week | Cleveland, Ohio |
| March 12 | Chicago District | Milwaukee, Wis. |
| March 13 | Philadelphia District | Philadelphia, Pa. |
| June 23–27 | Fiftieth Anniversary Meeting | New York, N. Y. |

### TM 25 Years Ago

*The newly organized Committee B-4 on etallic Materials for Electrical Heating t at Washington, D. C., on January 25 d 26, 1926, at which a number of plans re acted upon for conducting cooperative ts on heating elements. These included rious methods for conducting life tests, ysical and electrical tests, and methods of emical analysis.*

*Committee E-4 on Metallography sub-tted a tentative Recommended Practice for diographic Testing of Metal Castings.*

*Committee on Natural Building Stones med making total number of technical nmittees 45 with total committee member-ip at 2100.*

### TM 50 Years Ago

*The members of the Executive Committee t at the House of the American Society of echanical Engineers, 12 W. 31st St., w York City, on October 27, 1900. It s noted in the minutes: "On motion of . Dudley, the Executive Committee en-rsed and approved the bill before Congress ablishing a National Standardizing Bu-u." This was the forerunner of the pres-t Bureau of Standards.*

*At a later meeting of the Executive Committee, November 2, 1901, the question of having a permanent secretary was discussed. The minutes read: "Professor Porter's [then secretary] request, made at the meeting of the Executive Committee on June 29, 1901, to be relieved of the duties of the secretaryship, was considered. It was the thought that an effort ought to be made to secure the permanent services of a secretary who should receive a salary and devote much time to the work." A number of names were suggested, but no action was taken. At the meeting of March 8, 1902, Mr. Porter's resignation was accepted and Professor Edgar Marburg was appointed Acting Secretary.*

*Few ASTM members think of their Society as an anti-inflationary movement, yet the Chairman of the Fourth Annual Meeting in August, 1901, Prof. Henry M. Howe, spoke of this at some length in his address. Mr. Howe said, in part, "Our work is in effect to lessen the friction of the sale of the great materials of construction, and thus to do our share in lowering the cost and eventually the price of those materials. And since every class must use things made with or by, or transported with or by, these materials, our work makes, in the way which I have sketched, for the bettering, the widening, the uplifting of the family life and the family surroundings of every class."*

### ilding Codes and Construction ogress

A booklet has been re-ntly released by the Chamber of Com-rce of the United States, stressing the ponsibility of the individual community the modernization and sound ad-nistration of its building code. Local ambers and other interested groups are ged to share this responsibility in view rearmament demands requiring the most ective use of materials in defense con-uction. Uniform state legislation is ommended, requiring communities to ep their codes up to date and authorizing s complicated means of adoption by inicipal officials of standard codes and quirements. This has long been advo-ed in connection with reference to ASTM standards and the latest revisions thereof. Codes, said the Chamber, should be acceptable if they permit the use of methods and materials which comply with recognized standards or requirements developed through acceptable industry processes and by qualified agencies. The Chamber forsees an eventual practical degree of national uniformity in building codes if those in the nation's communities who are most concerned will busy themselves in that direction and accept the guidance of the responsible national organizations striving to accomplish that end.

Copies of this booklet are available, at 50 cents per copy, postpaid, from the Chamber of Commerce of the United States, Washington 6, D. C.

### Do You Have to Give a Talk? ASTM as a Subject!

Many of our members and committee members are called upon to give talks before service clubs, business organizations, or other technical groups. On numerous occasions, the Society and its operations has been the subject for a talk of this kind.

Within the past year, several papers on ASTM have been given before other organizations. Reference is made in this Bulletin to two such talks.

Society Headquarters will be glad to furnish information to any ASTM members who may have occasion to give a talk of this kind. This will include certain published information and copies of other talks, from which excerpts can be made.

The Society's work should be of definite interest to every businessman, and even nonengineering professional men. It can be described in an interesting way, as has been demonstrated on many occasions.

Members who are interested in receiving material that can be used as a basis for talks can contact Headquarters, and in doing so, if they will advise the type of audience, there may be certain special items which can be sent.

### Award of Merit Committee

With the acceptance of H. M. Hancock and William A. Zinzow, the personnel of the 1952 Award of Merit Committee is completed. These two men will serve with hold-over members, Louis J. Trostel (as Chairman) and Dean Harvey and C. H. Fellows representing the current Board of Directors on this committee. Page 595 of the current Year Book gives the rules governing the Award of Merit in which the ASTM technical committees have an important part.

### NBS Standard Samples and References

A 28-page booklet issued by the National Bureau of Standards lists and describes the standard samples and reference standards that have been issued by the Bureau. This is a supplement to National Bureau of Standards *Circular 398* and the booklet can be procured from the Superintendent of Documents, Washington 25, D. C., at 20 cents per copy.

# DISTRICT ACTIVITIES

## President Fuller at First ASTM Meeting in Louisville

At a well-attended meeting in Louisville, held jointly with the Louisville Section of American Society for Metals, the ASTM Ohio Valley District was host to President Truman S. Fuller, General Electric Co., Schenectady, N. Y., who also was the principal speaker of the evening, giving his address "Solving Problems in Materials." This was the first District meeting held in Louisville. There are several dozen ASTM members in this city and its surrounding industrial area, many of whom attended the meeting to greet the President.

The meeting was really in three parts. In the afternoon, several industrial plant visits took place, with groups going to Reynolds Metals, International Harvester, Brown & Williamson, and the Seagram plants. Then, at the dinner, there was an interesting coffee talk by Rev. William W. Slider, who gave an inspiring message on "Testing Mettle," during which he stressed the importance of man's having some of the attributes that are associated with the properties of metals, for example, malleability, resistance to shock, and stability. Speaking to technical men somewhat in their own language, Mr. Slider drew hearty applause.

At the technical session in the auditorium of Speed Scientific School, University of Louisville, a short distance from the University dining hall, where the dinner was held, ASTM Assistant Secretary R. J. Painter spoke briefly and then introduced the President. This was the first presentation of the talk that the President has developed for use in the Districts, and it was received with keen interest. He developed case histories of problems that had arisen in various phases of the electrical manufacturing industry and noted the solutions of these, together with the very much enhanced or modified properties that the engineer had developed in materials he had to use. Among subjects touched on were low pitch copper, certain insulating materials, various alloys used at elevated temperatures, the use of nondestructive testing, and problems of corrosion due to fuels used in jet engines. An excellent group of slides, many in color, provided pertinent illustrations.

A number of men from both ASTM and ASM cooperated in the numerous arrangements. Fred C. Smith, Tube Turns, Inc., spark-plugged the meeting for the Ohio Valley District, and working with him closely were the Louisville ASM officers, including:

*Chairman:* Bruce L. McMillan, International Harvester Co.; *Vice-Chairman:* Milton P. Niemeier, Tube Turns, Inc.; *Secretary-Treasurer:* Carl L. Ov[illegible] Jr., International Harvester Co.; [illegible] *Chairman, Arrangements:* Chester [illegible] Jenkins, International Harve[illegible] Co.

A number of ASTM members, [illegible]pecially the Ohio Valley Council[illegible] came a considerable distance for [illegible] meeting. Chairman J. C. Harris, [illegible] Monsanto Chemical Co., was down f[illegible] Dayton, Ohio; Vice-Chairman J. [illegible] Calbeck, of American Zinc Sales [illegible] came on from Columbus, Ohio; [illegible] John C. Pitzer, The Formica Co., [illegible]trict Secretary, came down from C[illegible]cinnati. Other councilors present [illegible]cluded: R. S. Armstrong, of Stan[illegible] Oil of Ohio, Lima, Ohio; Archi[illegible] Hurtgen, Henry Vogt Machine [illegible] Louisville; D. E. Krause, Gray [illegible] Research Inst., Inc., Columbus, O[illegible] and Professor W. B. Wendt, Unive[illegible] of Louisville.

Professor Wendt, who cooperate[illegible] arranging facilities at the Univer[illegible] was introduced at the meeting as ha[illegible] been a member of ASTM longer t[illegible] any of those present, his member[illegible] dating from 1916.

This was another in the series of [illegible]trict meetings sponsored jointly [illegible] the local sections of another so[illegible] where those assigned responsibility [illegible] following through did so effecti[illegible] with an excellent meeting resulting.

## Philadelphia District Holds First Meeting in Lehigh Valley

By sponsoring jointly with the Lehigh Valley Section of the American Society for Metals a technical meeting in Allentown, the Philadelphia District has joined the growing number of ASTM District Councils which have sponsored meetings in industrial centers other than the large city that constitutes the main center of activity. At this meeting, held in the Hotel Traylor on November 2, the main technical feature was the interesting address on "Solving Problems in Materials, Particularly Metals," by President Truman S. Fuller.

The Philadelphia Council has discussed, on several occasions, the desirability of a meeting in the Lehigh Valley—in Bethlehem, Easton, or Allentown—and the excellent one which was held, can be attributed largely to the interest of W. C. Clements, Bethlehem Steel Co., a Council member, who in close cooperation with the Lehigh Valley Chapter of ASM, handled all details. Prior to the dinner, at which A. O. Schaefer, Chairman of the Philadelphia District, was the Coffee Speaker, there was a social period (punch bowl).

In his talk "Just Problems," Mr. Schaefer indicated that the Philadelphia District had no particular problem or troubles because of the close cooperation of councilors, members, and Staff, but noted that industry today, particularly some of the metals working branches, has plenty of them, particularly aggravating because of the constant change of production schedules due to complications in the allocation of essential materials. He referred to the great changes in the last decade or two in the testing of steel forgings, noting the scie[illegible] and technical advances, including n[illegible] new inspection tools now in regula[illegible] to evaluate the quality of forgings c[illegible] kinds.

In the afternoon, Mr. Clements [illegible]ranged a trip through the Bethle[illegible] plant, with about 40 ASTM and A[illegible] members taking part. There was a[illegible] representation of the Philadelphia [illegible]trict Council. Despite very [illegible] weather, there were some 150 prese[illegible] the technical session.

Among those at the dinner mee[illegible] were the Mesdames Fuller (Senior [illegible] Junior), Winkler, and ASTM Hono[illegible] Member Wilson C. Hanna, Califo[illegible] Portland Cement Co., Colton, C[illegible] who was in the East on a business [illegible] including attendance at comm[illegible] meetings.

Presiding at the dinner was Robe[illegible] Fischer, Chairman ASM Lehigh V[illegible] Chapter.

## ew England District Hears ectures on Radioisotopes

THE Fall Meeting of the TM New England District was held the Commander Hotel, Cambridge, iss., October 9, on the subject of adioisotopes" with two experts in this d, Professor John W. Irvine, Jr., issachusetts Institute of Technology, l A. F. Rupp, Superintendent, Radiotope Development Department, Oak lge National Laboratory, as co-lecers.

Among the guests at dinner were Mr. M. Gaudin representing the Ameri- ı Society of Mechanical Engineers, H. Barry representing the American titute of Mining and Metallurgical gineers, J. T. Blake representing American Chemical Society, Dow M. binson representing the American iety for Metals, and E. A. Burrill resenting the Society for Non-Deictive Testing.

Chairman H. H. Lester also introed J. W. Caum, representative from adquarters, Philadelphia, who ught the latest word on plans for the 2 (50th Anniversary) Meeting to be d in New York. R. W. McMaster is deliver the Marburg Lecture on the ject of Non-Destructive Testing.

Following the dinner, other members guests arrived bringing the total endance to 130. The attendance ord cards showed at least eleven ns or cities and 34 organizations resented.

Councilor Daniel Cushing, Consulting tallurgical Engineer, then introduced F. Rupp, of the Oak Ridge National oratory, who gave an interesting ount of the intensive and elaborate cedures that have to be followed in ny cases to separate radioactive isoes from base-contaminating maals. Interesting also was the description of the white glow seen at night in the evaporators, indicative of the concentration of radioactive materials and the disturbing problem encountered when 90 per cent of the radioactive material finally attaches itself to the walls of the container vessels.

ASTM dinner, Commander Hotel, Cambridge, Mass. Left to right: R. H. Brown, D. M. Robinson, A. M. Gaudin, J. T. Blake, E. H. Barry, and E. A. Burrill.

etary C. G. Lutts and Chairman H. H. er of New England District Council Fall Meeting in Cambridge, Mass.

Mr. Rupp brought with him an intriguing film entitled "Engineering for Radioisotopes." This showed, for example, an order being received at Oak Ridge for radioactive iodine for hospital use, and the making up of the package, ready for shipment within a total of 20 min. In this time the bulk storage bottle containing the radioactive iodine was removed from its heavy walled storage vault, its stopper withdrawn, a pipet entered into the bottle, a transfer made to the smaller bottle which is finally capped and packed in a carton—all accomplished without contact by human hands.

Professor John W. Irvine, Jr., was introduced by Dr. L. S. Foster, and again the lecturer gave his audience items of outstanding interest. In the flow of oil through pipe lines, the division point between the end of a gasoline shipment and the start of a heavy oil can be accurately followed by means of a radioisotope and a Geiger counter detector. Thus our modern pipe lines can transport many types of material safely and with certainty.

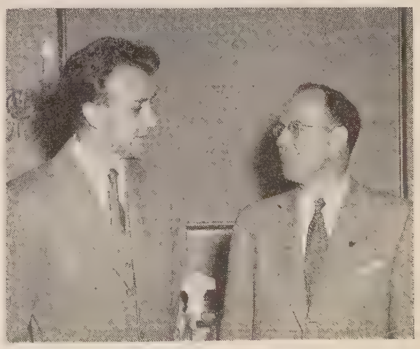
Concerning the distribution of DDT by airplanes, the addition of radioactive manganese in the form of an oil-soluble salt makes it possible to measure down to ten grams deposit per acre. The manganese addition is short lived and becomes harmless after a short period. Friction between metals is under investigation through the aid of radioisotopes. The manner in which carbon diffuses throughout steel is again studied with relative ease through the use of C 14. Professor Irvine described many of these impressive advancements through radioisotopes.

The sustained and friendly applause the lecturers received reflected the appreciation of the audience for a splendid evening.

## President Fuller at New York District Meeting

THE New York District was host to President Fuller on October 26, following a dinner of the Councilors at the Engineers' Club. The President gave his interesting talk on "Solving Problems in Materials" at a technical session in the Engineering Societies Building. This was followed by a showing of the film "Jet Propulsion." H. C. R. Carlson, District Chairman, presided, introducing a number of the officers and Staff in the audience. Jerome Strauss, Vanadium Corp. of America, Technical Program Chairman, spoke briefly, introducing President Fuller.

Following the meeting, there was general discussion.



Professor John W. Irvine, Jr., and A. F. Rupp, speakers on radioisotopes at New England District Meeting.

Speakers' table at ASTM-NACE meeting. Left to right: T. K. Cleveland, T. P. Dresser, Jr. (standing), David Hendrickson, F. L. LaQue, L. A. O'Leary, A. Wachter, and H. A. Schade.

## ASTM and NACE Hold Joint Meeting in San Francisco

ASTM Northern California District held a joint meeting with the San Francisco Bay Area Section of the National Association of Corrosion Engineers on October 31, at the San Francisco Engineers Club to hear an address by Frank L. LaQue on "Corrosion Testing and Engineering."

Dr. LaQue, who is in charge of Corrosion Engineering Section, Development and Research Division, The International Nickel Co. Inc., and was the 1951 ASTM Marburg lecturer, covered in his talk eight or ten aspects of corrosion from his Marburg Lecture. This was one of several talks he was scheduled to give in the course of a special trip to California.

The technical meeting, with 181 in attendance, was preceded by a dinner and an informal get-acquainted period.

L. A. O'Leary of W. P. Fuller and Co., who is chairman of Northern California District of ASTM, also acted as chairman of the meeting. He introduced Dr. A. Wachter of Shell Development Co., past president of NACE, who spoke on the work of NACE; and Dr. T. K. Cleveland, of Philadelphia Quartz Co., a Northern California District Councilor who spoke on the work of ASTM.

Following Dr. LaQue's talk the chairman formally adjourned the meeting but invited those present to stay for an informal question period which continued for about half an hour.

Among the ASTM District officers who aided in the meeting were vice-chairman P. V. Garin, secretary H. P. Hoopes and Theodore P. Dresser, Jr., past member of the ASTM Board of Directors.

## President's Night in Pittsburgh

A MOST ENJOYABLE an interesting evening was had by tho attending the President's Night spo sored by the Pittsburgh District Counc at the Royal York Apartments c October 23. A dinner was held pr ceded by a social hour, with approx mately 80 in attendance. Presiden Fuller's talk on "Solving Problems Materials" which followed the dinn was greatly appreciated by those a tending. In it he demonstrated in most striking manner the astoundi advances that have been made in pow generation through the use of improv materials.

The Staff was represented by Assis ant Executive Secretary R. E. Hess wh commented briefly on the broad sco of the Society's technical activities an who called attention to the intensi work on the part of the many technic committees. The acceptance and vali ity of the Society's standards is a dire result of the very careful manner which the committees go about the work and are a reflection of the technic competence of the committee membe which the committees are quite jealo of maintaining.

Arrangements for the meeting we handled by the Pittsburgh Coun Officers, namely M. D. Baker, We Penn Power Co., Chairman; F. Mavis, Carnegie Institute of Tec nology, Vice-Chairman; and H. Hebley, Pittsburgh Consolidation C Co., Secretary. The council membe cooperated in stimulating interest the dinner and meeting.

## Western New York–Ontario Members Hear President Fuller

DESPITE very inclement weather, with rain and wind howling in from Lake Erie, there was an excellent meeting sponsored by the Western New York–Ontario District in Buffalo on October 24, when President Fuller gave his paper on "Solving Materials Problems in the Electrical Manufacturing Industry." Also featuring the meeting was a sound, color film "Jet Propulsion." Preceding the technical session, which was held at the Hotel Sheraton, was an informal dinner.

This district covers western New York State and Ontario, and various industrial centers were represented at the meeting including Elmira, Rochester, Niagara Falls, and several Canadian cities, including Hamilton and Toronto. There were also two visitors present from England.

Arrangements for the meeting were handled by District Chairman L. F. Hoyt, Allied Chemical and Dye Corp., and Secretary Fred A. Webber, Wickwire Spencer Steel Div., The Colorado Fuel and Iron Corp., with Vice-Chairman Joseph Gentile, Pittsburgh Testing Laboratory, cooperating.

Members of the engineering fraternity in the Buffalo area were invited, and there were quite a number from other groups, including the American Society for Metals present.

Among those introduced during the meeting were Past District Chairman T. L. Mayer, and ASTM Assistant Secretary R. J. Painter.

**HOW DO YOU LIKE THE 1951 BULLETIN INDEX?**

**The development of a Subject Index style that will be most useful to our memb as well as compact, has been the topic much discussion at ASTM Headquart The ultimate objective is the compilati of a 50-year index covering all Soci publications up to and including 1950.**

**One procedure commonly followed "accepted indexing circles" is used in Index to the 1951 ASTM BULLETIN cluded in this issue on page 65. In previ subject indexes of technical papers, title and authors were listed under subj "key words." In this BULLETIN the Ind is by subject listing only.**

**We will appreciate very much receivi any comments you may care to offer.**

# TECHNICAL COMMITTEE NOTES

## Sandwich Construction Committee Holds Two Day Meeting—Visits National Bureau of Standards

THE FALL meeting of Committee C-19 on Structural Sandwich Constructions combined subcommittee meetings, an inspection trip through the National Bureau of Standards, Washington, D. C., and a dinner and papers session. The meeting, held on October 22 and 23 at the Bureau, included a review of a number of proposed tentative test methods already submitted to letter ballot and discussion of additional methods under consideration.

It is felt that sufficient tentative methods have been developed generally to cover the mechanical properties of basic materials used in sandwich construction. The need for methods of testing electrical properties was felt not to be sufficiently developed at this time, and therefore any program in this direction is being deferred. A need was expressed for proper interpretation and description of heat distortion. Proposed tentative methods for measuring flammability and for thermal expansion were announced as nearing completion.

Bondability, creep, and peel were discussed by the Subcommittee on Mechanical Properties of Basic Sandwich Construction. A questionnaire will be circulated for an expression of the interest in these properties. The development of an impact test was suggested, and a study will be made of the adaptability of the existing ASTM Tentative Methods of Conducting Strength Tests of Panels for Building Construction (E 72 T).

Participation in a program for using ASTM exposure test sites was discussed with further information to be determined as to the responsibilities of the committee in connection with such a program. In the absence of further information on a proposed design of a test cubicle, it was the consensus that it would be more feasible to consider small beam specimens for the test site program. The need was expressed for a standardization of test temperatures and ranges in determining the effect of weathering on physical properties of sandwich construction, with both elevated and subzero temperatures included. Contact will be maintained with the Subcommittee on Conditioning and Weathering of Committee E-1. A draft will be prepared for a cantilever beam fatigue test method.

An added feature of the meeting was a dinner held on the evening of October 22 at the Wardman Park Hotel, at which time two interesting papers were presented. E. W. Kuenzi, Forest Products Laboratory, discussed "Flexure in Structural Sandwich Construction," and R. L. Whann, North American Aviation, Inc., presented a paper on "Application of a Standardized Stock Metal Sandwich Paneling in Aircraft." The committee will hold its next meeting during the 1952 Annual Meeting of the Society in New York City.

## Committee B-8 Holds Meeting at Headquarters

### Much Technical Work Underway on Electrodeposited Coatings

COMMITTEE B-8 on Electrodeposited Metallic Coatings, for the first time since its formation, held a meeting at ASTM Headquarters on November 7 and 8.

Subcommittee IV on Electroplating Practice is continuing its high rate of activity, having drafted a proposed recommended practice for preparation of copper and copper alloys for plating. The interest of jewelry manufacturers and newspaper publishers has resulted in a task group of this subcommittee undertaking the development of a recommended practice for the preparation of lead and lead alloys for plating, and a recommended practice for the preparation of gray and malleable iron for plating is under way.

In view of the large number of recommended practices emanating from Subcommittee IV, it was agreed that a general format should be adopted which would facilitate comparing similar sections of various practices.

Cognizance is being taken of a glossary of terms dealing with electroplating practices that is under preparation in the American Electroplaters Society. It was agreed that a liaison should be established between the ASTM and the AES in order to avoid duplication of effort. Such a joint effort should result in broader basis of acceptance for this glossary when published.

The question of the advisability of using a copper strike on steel preparatory to subsequent nickel-chromium deposits has been a question of controversy for several years. In an effort to definitely establish the advisability of using a copper strike, a supplementary set of panels will be exposed at Kure Beach, New York, and Detroit. Five sets of 24 panels each will be exposed at the three locations, and it is hoped that the question of the effectiveness of various thicknesses of copper strikes can be settled as a result of these exposures.

A special group was appointed to study the problem of rating panels. Panels are sometimes rated according to appearance regardless of protective value. In others failure of surface is judged by pitting even though the general appearance of the panel is good. It is hoped that some method of rating can be developed whereby both of these questions can be taken into consideration.

There appears to be a renewed interest in the use of nickel coatings applied over plated finishes. The original interest came from the manufacturers of refrigerators and has now been augmented by the use of such coatings in the automotive industry.

Work is continuing on the use and expected service life of both chromate and phosphate treatments. One of the problems facing the group studying phosphate treatments is how best to simulate warehouse storage conditions.

It was agreed by the committee that the B-8 specifications should have thicknesses designated in mils rather than in inches and also to include micron equivalents. Each specification would have a footnote indicating equivalents, and this footnote would probably be carried for a number of years.

The need was pointed out for some means of publishing photomicrographs or some similar method which would identify typical structures of various electrodeposited coatings. It was agreed that such work is necessary and the question will be considered again at the next meeting of the committee which will be held during Committee Week in Cleveland during the week of March 3.

# Interesting Meeting on Electrical Alloys

### Discussion on Resistor Fine Wire; Paper on Trace Elements

One of the most interesting items discussed at the meetings of Committee B-4 on Electrical Heating, Resistance, and Related Alloys at ASTM Headquarters on November 1 and 2, concerned the desirability of preparing satisfactory specifications for enameled wire used in precision-wound resistors. This wire usually has an extremely fine diameter, being of the order of 0.0009 to 0.002 in. Representatives from Wright Field and Hughes Aircraft pointed out the necessity for such specifications in view of the variance in wire now being supplied for such use. Both producer and consumer interests agreed standardization would be desirable in this field.

The program of Subcommittee VIII on Metallic Materials for Radio Tubes and Incandescent Lamps calls for a full work schedule including changes in the diode method which was appended to the 1950 report as information and which the subcommittee hopes to have ready for presentation to the main committee at the Spring Meeting and subsequent approval by the Society in June. This June goal also applies to a sublimation method. There are at present two methods under consideration and it is hoped that current work can resolve any differences in opinion so that a preference can be shown for a single method. Work is progressing on methods for the gravimetric analysis of the elements present in cathode nickel.

After two years of round-robin testing of various methods of weighing fine diameter wire, a specification for such weighing is now being drafted. This method is intended to be for referee measurements rather than routine.

Work on spring back and cup testing methods of physical testing are continuing as are the studies on the flow rate of gases.

### Paper on Trace Elements

Committee B-4 recently initiated the practice of having a part of each meeting allotted for the presentation of a paper in some particular field of general interest to the committee. At this meeting Roger W. Loofbourow of Merck and Co. presented a paper on "The Spectrographic Approach to the Trace Element Problem." In recent years, smaller and smaller percentages of elements have been recognized as evidenced by the number of patents covering alloying constituents of the order of 0.001 to 0.01 per cent. Recently a patent was issued covering the addition of 0.00005 per cent (0.5 ppm) beryllium to magnesium. Mr. Loofbourow emphasized that a tremendous amount of "over selling" had been done and that many a spectrographer has had to re-educate executives who have been sold the idea that science is infallible, the instruments without flaws, and the only reason for failing to supply the completely satisfactory answer to any problem is human frailty. In this connection Mr. Loofbourow referred to a paper in the literature describing the use of the spectrograph as a means of "...a differentiation between healthy and decomposed potatoes." Although he hadn't read the paper, he felt sure there must be a simpler way.

He pointed out that the unique value of the spectrograph lies in four characteristics:

1. Its ability to give a rapid qualitative analysis covering some 75 elements.
2. Its ability to give quantitative determinations on any selected group of the 75 elements at low levels of concentration.
3. Its ability to supply the analyst with a speed far superior to that of conventional chemical methods.
4. Its ability to supply a permanent photographic record of the analysis which can be referred to months or years after the sample is run.

# Smith Memorial Medal Awarded to Edward R. Schwarz

Professor Edward R. Schwarz, Head of the Textile Division of the Massachusetts Institute of Technology, received the Harold DeWitt Smith Memorial Medal on October 16 at the Fall meeting of ASTM Committee D-13 on Textile Materials held in New York City.

The presentation, made by Committee D-13 Chairman William D. Appel at a luncheon ceremony at the Park Sheraton Hotel, marked the second time this memorial medal, endowed by the Fabric Research Laboratories of Boston, has been awarded. The first recipient was Herbert F. Schiefer of North Carolina State College.

Tributes to Professor Schwarz were made in addresses on "The Medalist, the Scientist," by Stanley Backer of MIT and on "The Medalist, the Man" by Rogers B. Finch also of MIT. The speakers stressed the outstanding contribution of Professor Schwarz in the field of textile engineering research and education, and recognition of his position as one of the individuals who best exemplify the highest ideals in scientist and responsible citizen.

*Courtesy Daily News Reco[rd]*

Among those present at the D-13 luncheon in honor of Professor Schwarz, Smith Memorial Medalist, are, seated, left to right: H. F. Schiefer, N. C. State College; S. Backer, M.I.T.; F. Bonnet, American Viscose Corp.; Professor Schwarz; W. D. Appel, National Bureau of Standards; W. J. Hamburger, Fabric Research Laboratories, Inc.; W. H. Whitcomb, Secretary of D-13; R. B. Finch, M.I.T. Standing, left to right, are: K. L. Hertel, University of Tennessee; A. G. Ashcroft, Alexander Smith, Inc.; A. G. Scroggie, E. I. du Pont de Nemours & Co.; M. E. Campbell, N. C. State College; R. T. Kropf, Belding, Hemingway, Inc.; J. S. Jacobs, Textile Research Institute, Inc.; S. L. Hayes, Ludlow Manufacturing & Sales Co.; G. H. Hotte, A. M. Tenney Associates, Inc.

## Much Research Work Under Way in Committee D-14 on Adhesives

Among the important subjects being studied in Committee D-14 on Adhesives as reported at the Fall meeting held in Detroit, October 15 and 16, are creep, solids determination, accelerated service test, tack measurements, and shrinkage testing. Much research work is under way in the committee to provide needed data in order to standardize various specifications and tests.

It was announced that at the 1952 Fall meeting of the committee there is to be a session on nondestructive testing of adhesives.

With several types of strength tests already adopted as ASTM standards, Subcommittee I reported on further test methods, including the development of a simple type of tensile strength test and equipment for use with wood-to-wood joints. The problem of developing a method for measuring creep is still presenting difficulties, the principal one being that of the need for a larger type testing machine than normally used for testing adhesives. The section on creep will extend its activities to include a study of thermosetting adhesives.

Subcommittee II on Analytical Tests has completed its second round-robin series on solids determination on urea resins. The ASTM Tentative Methods of Testing Varnishes Used for Electrical Insulation (D 115 T), slightly modified to include the use of a drying dish, has been used in these tests for comparison with the PMMA method, and it is felt that the ASTM method has given a more realistic value. It is planned to publish an article giving data and conclusions on the suitability of the ASTM method.

Written reports were presented covering further work in Subcommittee III on Tests for Permanency on accelerated service tests on resin-bonded phenolic plastic material. As a result of this additional data, cycle A has been modified and will be known as cycle A-1, the change consisting of a decrease from 48 to 24 hr at both 23 and 48.5 C temperatures and the addition of a fourth section of the cycle consisting of 48 hr at 48.5 C and uncontrolled relative humidity. The need was expressed for a strength test method to establish the bond of metal-to-metal adhesives.

Additional methods are being prepared to study the effect of biological factors on adhesives. In attempting to correlate short-time and long-time tests for permanency, plans were discussed for round-robin series which would be organized, making use of the nationwide ASTM exposure test sites.

Three groups of silicone adhesives are being used in the testing program for measuring tack by a section of subcommittee IV or Working Properties. With these adhesives, it is hoped to establish a K factor or machine constant for use with the proposed testing apparatus which has been agreed upon. Two proposed recommended practices were distributed for comment and for later letter ballot. These cover the determination of storage life and working life of adhesives.

An activity reported by Subcommittee V on Specifications was in reference to the Proposed Specifications on Acoustical Tile. Methods have been formulated for round-robin tests which will be inaugurated for the purpose of securing additional data, one of these methods to measure shrinkage, either linear or volume. A 4-in. ceramic disk has been selected as a standard surface piece due to its availability. Action was taken to authorize a new section to prepare a standard method of sampling which was felt necessary in connection with the development of any specifications.

Several additions to the definitions of terms were approved for letter ballot of the committee. These include definitions of dispersion, syneresis, thixotropy, doctor bar or blade, doctor roll, pick-up roll, and warp.

Nondestructive testing was emphasized by Subcommittee VII on Research Problems to replace routine tests. With this in mind, a session will be organized at the 1952 Fall Meeting of the committee for informal discussion on this subject. The use of strain gages was suggested as an effective tool. Continued attention will be given to sonic methods for testing glue lines.

Additional properties to be measured were suggested for inclusion in the proposed Method for Testing Electrical Properties of Adhesives, one of these being d-c conductance. A revised draft will be circulated for further comments, and it is planned to submit final drafts of proposed methods to Committee D-9 on Electrical Insulating Materials for review.

The next meeting of the committee will be in connection with the 1952 Annual Meeting in New York City. The committee will sponsor a Symposium on Durability and Performance of Adhesives at that time.

## Porcelain Enamel Group Meets in Milwaukee

The Fall meetings of Committee C-22 on Porcelain Enamel held on September 27–28 in Milwaukee, Wis., were followed by a tour of the A. O. Smith Corp. plant, in line with the recent policy of the committee to hold meetings in cities where visits to interesting plants and laboratories can be made part of the program. Previous meetings have been held at Batelle Memorial Institute in Columbus, Ohio, and at the Westinghouse Electric Corp. in Mansfield, Ohio.

The committee is vigorously pursuing its program of developing additional test methods for ASTM adoption following the acceptance of four initial proposed methods submitted to the Administrative Committee on Standards in September, as follows:

- Test for Sieve Analysis of Wet Milled and Dry Milled Porcelain Enamel (C 285 – 51 T).
- Test for Impact Resistance of Porcelain Enameled Utensils (C 284– 51 T).
- Test for Resistance of Porcelain Enameled Utensils to Boiling Acid (C 283 – 51 T).
- Test for Acid Resistance of Porcelain Enamels (C 282 – 51 T).

A time schedule has been set up for final consideration and balloting on proposed methods for measuring reflectance, adherence, abrasion, and thermal shock, these methods to apply to finished products. A fineness test adopted from the Porcelain Enameling Institute test, applying to raw materials, is expected to be ready for letter ballot in the near future. Investigation is under way on test methods for determining torsion, the analysis of water for mill additions, the consistency of enamel slips, the evaluation of enameling iron, and a tearing test. Progress was reported on the development of tests on finished products to measure warpage, gloss, thickness, and the resistance of chemical ware to water and alkali.

The Research Subcommittee discussed at some length the desirability of developing and appraising thermal-shock tests and a task group was organized to work on this project. A new project was added to the research program concerning the short- and long-time effects of porcelain enamels and underlying metals as used at various temperatures, for which a task group was appointed.

# Much Activity at Purdue Meetings of Committees on Cement and Concrete

THE Purdue University campus was the scene of the combined Fall meetings of Committees C-1 on Cement and C-9 on Concrete and Concrete Aggregates. The main meetings of both committees were held on October 26, preceded by meetings of the subcommittees on October 24 and 25.

Through arrangements made by K. B. Woods, Professor of Highway Engineering and Chairman of Committee C-9, meeting rooms were provided at the Purdue Memorial Union in addition to hotel accommodations. Both groups expressed their pleasure in meeting at one of the country's great universities.

Notable progress is being made in subcommittee work on many important projects. A brief résumé of the reports presented is made in the following paragraphs.

## Committee C-1 on Cement

The Cement Reference Laboratory reported on the completion of inspection trips made through New England, New York, and Canadian laboratories. There is an encouraging prospect that standard samples of cement for chemical analysis purposes will be made available shortly, these samples to be in lots of three 10-g vials.

A revision of the flame photometry test method (C 228 T) is being studied with the objective of approving several types of flame photometers for use with this method.

A reduction of the solution concentration and elimination of the lime content in the zero standard are also being considered. Cooperative tests are now being conducted to establish a better method for removing manganese.

Accelerated alkali reactivity tests are being conducted for possible revision of the tentative test method (C 227 T). Concern had been expressed, previous to the meeting, over difficulties in some states of the acceptance of the autoclave apparatus as used in ASTM Method C 151. Work on this problem is in progress looking toward having the equipment recognized for the use intended by boiler code authorities and insurance companies. A report is in preparation which will present data on autoclave expansions of a large number of cements and length changes of the cements in neat cement and 1:2 mortar prisms during storage in water and in air for periods up to ten years.

A considerable amount of data has been collected on the subject of sulfate resistance, including a review of the latest cooperative series of tests involving 17 laboratories and 13 cements. A proposed test method will now be prepared for information purposes, using the lean mortar bar procedure. A quick method for determining resistance to sulfate action will also be written for information purposes based on a cooperative series using sulfate susceptibility tests on the same cement.

A complete report on the investigation on heat of hydration will be presented at the time of the Spring Meeting of the committee. In the study of bleeding characteristics, the results of a cooperative series involving ten laboratories will now be tabulated for the committee. A mechanical mixing procedure will be included in the report, and a new series of tests is planned involving three cements using new apparatus just completed. Several methods are being considered to measure workability. A need was expressed for clarification of the requirements for fineness, and a cooperative series of tests will be made to establish data. A need was also expressed for a method using the Lee-Nourse apparatus which is used for research work, especially on cements other than portland.

Two proposed methods for measuring strength of hydraulic cement mortars have been prepared for circulation and comment of the committee. This involves flexural strength of mortar and a compressive strength using portions of specimens used in the flexure test. The proposed method for determining the presence of calcium sulfate in hydrated portland-cement mortars is now being tried out by producers. Closer requirements on the apparatus for measuring air content of hydraulic cement mortars (C 185 T) have been discussed, and cooperative tests among eleven laboratories to establish the proper revisions to be made are expected to be completed at the time of the Spring Meeting.

Proposed revisions of the specifications for portland cement (C 150 and C 175 T), recommended at the last meeting and which subsequently were referred back to the committee by the Administrative Committee on Standards due mainly to the lack of opportunity for review of the negative comments, were reaffirmed upon recommendation by the Sponsoring Committee on Portland Cement. These revisions pertain to inclusion of Blaine air permeability test fineness requirements and the elimination of the initial time of set requirements. These revisions will again be submitted to the Society, and investigation will now be made to establish the need for the two fineness methods referred to in the specifications.

Results are expected by the next meeting on tests being conducted on hand- and machine-mixed masonry mortars.

A change in the natural cement specifications (C 10 T) was approved for letter ballot, which will now specify the Vicat time of set method (C 191 T) to be used with the same limits as now specified.

Minor revisions in the proposed specifications for fly ash and for fly ash portland cement were reported as a result of cooperative series of tests involving five laboratories and 25 samples of fly ash. Further tests are still under way.

A proposed specification for pozzolanic materials was reported under preparation.

## Committee C-9 on Concrete and Concrete Aggregates

Final approval on a proposed tentative method of test for determining chemical reactivity of aggregates by chemical methods is expected at the Spring Meeting of the committee. At least two papers are being planned on chemical reactivity for inclusion in a symposium to be presented at the 1952 Annual Meeting on the subject of durability of concrete.

A. D. Conrow presented a brief progress report on variations in expansion of mortar bars.

The method for determining the fundamental torsional frequency of concrete has been agreed upon for inclusion in the ASTM sonic method (C 215 T).

A proposed method for petrographic examination of aggregates for concrete will be distributed as information.

A proposed method for center-point loading in the flexure test (C 192) for beams other than the flexure test specimens is being considered. This will include beams such as those used in the freezing-and-thawing tests.

A complete revision of the Standard Method of Sampling Fresh Concrete (C 172) is contemplated, but no details are noted at this time.

Revisions of the Standard Specifications for Concrete Aggregates (C 33), which had been submitted to letter ballot of the committee, were reviewed in the light of negative comments received. These revisions involve setting up specific limitations instead of those requiring the user to set limitations to meet local conditions. Agreement was reached on some items, but most of the revisions were referred back to the subcommittee for further consideration. It was agreed to eliminate the mortar strength requirement on fine aggregate and there was a question as to the need for soundness requirements for fine aggregate.

Due to considerable negative comments on the proposed tentative specifications for aggregates for lightweight concrete circulated at the last meeting, an entirely new approach will be made in the revision of this specification by the subcommittee. The new approach will be based on performance requirements of aggregates in addition to grading and other quality requirements.

The present Method of Test for Water Retention Efficiency of Methods for Curing Concrete (C 156 T) will be revised in terms of limiting its coverage to liquid membrane-forming compounds and paper sheets. Reproducibility of test results will be checked previous to the writing of specifications for these materials.

A draft of a proposed specification for fly ash admixtures was reviewed by the subcommittee with further revisions being recommended. This review included considerable data which have been collected by cooperative tests on 20 fly ash samples. It was noted that no consideration had been given to the effect of fly ash on the air content of concrete, and this will be studied further. The subcommittee

considering the addition of a sampling method to the Tentative Method of Testing Air-Entraining Admixtures for Concrete (C 233 T), based on an existing ASTM method for sampling petroleum (D 270 T).

The first cooperative test series to establish data for preparing a method to measure the resistance to abrasion of concrete will be made using the shot-blast apparatus. A question of considerable importance arising from discussion of this type of test is what to measure as the depth of skin or surface of the concrete. Other apparatus will be evaluated following this initial series. Specimens will be prepared using the same cement and aggregate.

The new subcommittee on setting time of concrete reported that considerable research is necessary due to the lack of availability of suitable apparatus. Various types of physical tests will be studied for their relationship including triaxial, flexure, tension, and other properties. In attempting to establish a standard method of making freezing-and-thawing tests, a subcommittee is now considering initially the development of three proposed methods involving rapid freezing and thawing in air, in water, and in brine, respectively. Later consideration will be given to a method involving slow freezing in air and thawing in water.

Both Committees C-1 and C-9 will meet at the time of the 1952 Spring Committee Week in Cleveland and at the Annual Meeting in New York City, at which time a symposium will be sponsored by Committee C-9 on Factors Affecting Durability of Concrete.

## Textile Materials Group Holds Record Meeting

A RECORD-breaking meeting in attendance and number of sessions was held by Committee D-13 on Textile Materials in New York City on October 15 to 17, with 240 members and guests present. Meetings of the subcommittees and their sections totaled twenty-five. In addition there were meetings of a large number of task groups that have recently been established to handle specific assignments.

One of the high lights of the meeting was the presentation of the Harold DeWitt Smith Memorial Medal to Prof. Edward R. Schwarz of the Massachusetts Institute of Technology. Further reference to this award is made elsewhere in this BULLETIN.

At a meeting on Tuesday, October 16, reports were received from the American delegates to the National Textile Standards Conference held in Bournemouth, England, June 4 to 9, 1951, dealing with the various international considerations given by ISO Technical Committee 38 to General Methods for Testing Yarns, Universal Yarn Numbering System, Definitions of Textile Terms, General Test Methods for Fibers and Cloth, Grab *versus* Strip Breaking Strength Tests, Commercial Moisture Regains and Allowances, Shrinkage in Laundering, and Colorfastness Test.

An organization meeting was held of a new Joint Committee of ASTM and the American Association of Textile Chemists and Colorists to coordinate the methods of both organizations and to provide a means for considering test procedures of interest to both groups.

A very interesting summary of data on Interlaboratory Check Sample Testing of Cotton was reviewed and action taken to have these data published in a report to be released in the near future.

Action and reports of subcommittees are summarized briefly below.

The Subcommittee on Ultimate Consumer Products considered initiating work on Test Methods for Elastic Fabrics, provided sufficient representation can be obtained from the producers of these fabrics. A method of test for all types of shower curtains for resistance to mildew and microorganisms is in final stage of revision. Definite progress is being made toward a method of test for slide fasteners. The task group handling this assignment contains representatives of retail, Army, Navy, manufacturing, and consumer interests. Further work is planned on abrasion tests of men's shirts and shirting. Four laboratories are cooperating in a series of field tests.

Another important study being undertaken will deal with the development of methods for measuring piling in fabrics made not only from man-made but also natural fibers.

The Subcommittee on Bast and Leaf Fibers reported completion of a set of methods of test for twine which were recommended to Committee D-13 for submission to the Society for publication as tentative.

The Subcommittee on Test Methods received reports from a large number of active task groups. The General Methods of Testing Woven Textile Fabrics (D 39 – 49) are being rewritten and the revised standard is expected to be completed for action at the March, 1952, meeting. A test method for determining luster of yarns is also being completed. This method involves determination of reflectance at right angles to the specimen and also at 0 and 45 deg.

Drafts of proposed consolidated methods for testing woolen and worsted yarns are under study and should be completed in time for issuance as tentative in 1952.

Preliminary studies of tests for yarn evenness using five different textiles were very successful. Certain details of the test procedure are now being given further study, and after these are worked out additional tests will be made on at least three machines of each of the five types. A definition of yarn evenness has been prepared and is being reviewed with the Definition Subcommittee.

Studies of tests for shrinkage of knit goods are being carried on with the AATCC. Additional work is planned on development of test methods for cotton knit goods. Data obtained on shrinkage tests of rayon knit goods are under study.

Another project being worked on cooperatively with the AATCC is the subject of light fastness of colored textiles. Consideration is being given to separating the two existing types of test into separate standards. Other subjects under study include stiffness and flexibility of fabrics; thickness of fabrics, that is, compressibility and recovery tests; crease resistance; identification of finishes on textiles; methods for the analysis of fiber mixture, and fire resistance tests. The Subcommittee on Pile Fabrics reported progress on its work on flame testing, color change in shampooing, tuft bind and abrasion testing, and also on the evaluation of mothproofing compounds.

At an organization meeting of a new task group a program was outlined for interlaboratory testing and sampling for determining the fiber content of part wool blankets. At a meeting of the Subcommittee on Statistical Data a paper was presented by C. A. Bicking, of the Research and Development Division, Department of Defense, Office of the Chief of Ordnance, on "Application of Statistical Procedures to Analysis of Textile Testing and Control Data."

At a joint meeting of the sections on Felt and on Bonded Fabrics, a paper was presented by C. L. Hazelton on "Factors Influencing Aerosol Filtering Properties of Fiber Web Structures."

### Expanded Scope of Committee D-16 Approved

AT THE June meeting of Committee D-16 on Industrial Aromatic Hydrocarbons, held in Atlantic City in connection with the ASTM 1951 Annual Meeting, the formal adoption and acceptance by the Society of the new scope of activity of the committee was announced.

The expanded scope of Committee D-16 now reads as follows:

> Nomenclature, specifications, and methods of test of those aromatic and heterocyclic chemicals, generically classed as coal chemicals, whether derived from coal, petroleum, or any other source, by synthesis or physical separation, and used industrially, either alone or as mixtures, as intermediates or solvents.

## Committee C-16 on Thermal Insulation Holds Fall Meeting

In line with its policy of selecting a site other than a metropolitan area for its Fall Meeting Committee C-16 on Thermal Insulating Materials met for three days at Skytop Lodge, October 15–17. A full schedule of subcommittee meetings, a main meeting and a dinner were held.

Several proposed tentative specifications were approved for letter ballot of the committee. In the block and pipe insulation field, two proposed tentative specifications covering cellular asbestos paper pipe insulation and laminated asbestos thermal insulation for pipes, respectively, were accepted, as well as a specification for mineral wool block or board insulation for low temperatures and a sampling procedure. Also under consideration in this field is a proposed method of test for resistance to vibration, and specifications for insulation made from cork board, cellular glass, lime-silica block, magnesia block and pipe, diatomaceous earth, and mineral wool insulation for roofs. Proposed new test methods on insulating cements are approaching completion covering adhesion of dried thermal insulating cements, compressive hardness, and plasticity of wet mixes.

The determination of the minimum density at which loose fill insulation should be applied was under discussion, and some exploratory tests will be made using the ASTM type of flow table. In connection with the matter of density, data will be developed on the volume change of loose fill insulation.

In reviewing the status of the two ASTM methods for determining thermal conductivity, it was agreed to retain the guarded hot plate method (C 177) in its present form, and minor changes were made in the guarded hot box method (C 236 T). A revised draft was reviewed by the subcommittee of a proposed tentative method of test for the thermal conductivity of pipe insulation.

Replies to a questionnaire sent to manufacturers to obtain information on recommended clearances between pipe and tubing and rigid molded thermal insulation for pipe have been received by a subcommittee and will be analyzed further to establish the feasibility of recommending clearances. The development of dimensional thickness standards will be held in abeyance, pending a further report on this analysis.

The Subcommittee on Vapor Barriers reported that information is needed on permeability as a function of a moisture content of an insulating material, the effect of film resistance and the effect of thickness on resistance to vapor transmission, and the effect of holes in the vapor barrier for resistance to vapor transmission. It is suggested that these three items be proposed to universities as possible projects for thesis study.

Plans are proceeding for the raising of funds and conducting the proposed research for determining the effects of moisture on the performance of thermal insulation.

## D-15 on Engine Antifreezes Holds Two-Day Meeting

A two-day series of meetings of Committee D-15 on Engine Antifreezes and its seven subcommittees and sections were held in Atlantic City on October 25 and 26. The committee received reports on the several cooperative test programs under way and acted on recommendations for revised standards for submission to letter ballot vote.

An informative publication on "Selection and Use of Engine Antifreezes," which has been prepared and sponsored by Committee D-15, has been completed for submission to the Society. This publication includes information of direct interest to the consumer on the selection, installation, and maintenance of antifreeze solutions in automobile and other types of engines, also on the use of cleaning compositions, techniques, etc.

The Study Group on Corrosion and Foaming Test Methods presented a detailed report covering the results of a questionnaire on the glassware type of corrosion testing. The report covered replies from 12 of the 14 laboratories solicited. Also presented was a Suggested Procedure for Glassware Corrosion Test of Engine Antifreeze based on the recommendations of the collaborating laboratories. Several changes in the suggested procedure were agreed upon at the meeting and arrangements made for conducting another series of cooperative tests using the revised method.

The Subcommittee on Freezing Point Determinations recommended several minor changes in the Tentative Method of Test for Freezing Point of Aqueous Engine Antifreeze Solutions (D 1177 – 51 T).

The Subcommittee on Chemical Properties took action recommending that the Study Group on Analytical Methods should concern itself only with the detection of antifreeze in crankcase oil, and also that the study of effects of antifreeze on the oil and engine is beyond the scope of the subcommittee. This recommendation was approved by Committee D-15.

A new study group was appointed to give consideration to the subject of Classification of Engine Antifreezes.

Consideration is being given to obtaining information on Low-Temperature Viscosity of Engine Antifreezes down to −60 F. The subject of evaporation of antifreezes as a heat transfer agent was also discussed.

Arrangements were completed for a cooperative test program to study the effect of antifreeze on rubber hose. It was decided to use in this investigation two types of rubber standards; one compound equivalent to the best type rubber hose and a second compound equivalent to the reclaim type of rubber hose. Two types of antifreeze will be used in these studies, both the alcohol and the glycol or permanent type. There will be two samples of each type—one with and one without soluble oil. The test procedure will be designed to determine the effect of antifreeze on the standardized rubber specimens.

### 1950 Literature on Lubrication

November *Mechanical Engineering* includes a digest of 1950 literature on bearings, lubricants, and lubrication. This report was prepared by Dr. J. C. Geniesse, The Atlantic Refining Co., with the assistance of the Special ASME Research Committee on Lubrication. It is based on the Engineering Index references. The digest covers: journal bearings and bearing materials, ball and roller bearings, thrust bearings, automotive lubricants, metal-working lubrication, boundary lubrication, and properties of lubricants. The bibliography gives 7[illegible] references.

### Change in Board Meetings in 1952

Because the stated dates of the January and May meetings of the Board of Directors would create considerable inconvenience in connection with certain activities, the Board has decided to change those dates. The January and May, 1952, meetings will be held at ASTM Headquarters as follows: January 21–2[illegible] and May 5–6.

# PERSONALS...

**News items concerning the activities of our members will be welcomed for inclusion in this column.**

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

At the recent annual meeting of the American Welding Society the following ASTM'ers were elected to office: **Fred L. Plummer,** Director of Engineering, Hammond Iron Works, Warren, Pa., became First Vice-President; **Eric R. Seabloom,** Supervisor of Field Engineering, Crane Co., Chicago, was named Second Vice-President; **Irving A. Oehler,** Director of Metallurgy and Research, American Welding & Manufacturing Co., Warren, Ohio, was elected a Director.

The Instrument Society of America at its Sixth Annual Instrument Conference and Exhibit, held in Houston in September, elected as President, **Arnold O. Beckman,** Beckman Instrument Co., South Pasadena, Calif. **Robert T. Sheen,** Consulting Chemical Engineer, Philadelphia, was named a vice-President.

In recognition of valuable services to the foundry industry over a long period of years, the Institute of British Foundrymen recently elected to honorary membership three prominent foundrymen—one an industrialist in Glasgow, the other two from this country. The latter, **James T. MacKenzie,** Technical Director, American Cast Iron Pipe Co., Birmingham, Ala., and **Oliver Smalley,** President, Meehanite Metal Corp., New Rochelle, N. Y., are active ASTM members. Dr. MacKenzie is a Past-Director of the Society and Past-Chairman of Committee A-3 on Cast Iron.

**Ford Bryan,** formerly Research Spectroscopist, Dearborn Engine Plant, Ford Motor Co., Dearborn, Mich., has been placed in charge of the Spectroscopy Section of the new Ford Scientific Laboratory.

**Fred Burggraf** has been appointed Director, Highway Research Board, National Research Council, Washington, D. C. Mr. Burggraf has been connected with research relating to highways since 1919. His career has included engagements with the National Bureau of Standards, the Illinois Division of Highways, and the Calcium Chloride Association. He served as Research Engineer of the Highway Research Board 1928–1932, and returned to the Board as Assistant Director in 1940. He was named Associate Director in 1945.

**Stephen L. Burgwin,** formerly Advisory Control Engineer, Westinghouse Electric Corp., Buffalo, N. Y., is now associated with the Minneapolis-Honeywell Regulator Co., White Bear Lake, Minn., as Electrical Engineer.

**Gregory Jamieson Comstock,** Director of the Powder Metallurgy Laboratory at Stevens Institute of Technology, Hoboken, N. J., was awarded the Certificate of Appreciation from the Department of the Army, the citation reading "for services with the Technical Industrial Intelligence Committee, Joint Chiefs of Staff, World War II." Following service in Germany in the Second World War Professor Comstock was connected with the Foreign Economic Administration, Washington, D. C., and later was with the U. S. Department of Commerce under the Office of Production, Research and Development.

**William M. Coopman,** formerly City Civil Engineer, Moline, Ill., is now Vice-President, Valley Construction Co., Rock Island, Ill.

**Bailey S. David** has been named Head of the Analytical Section, Quartermaster Pioneering Laboratories, Philadelphia, Pa. Until recently he was Chief, Physical Chemical Sec., Smith, Kline & French Labs., in the same city.

**William J. Edgar,** formerly Chief Spectroscopist, Charles C. Kawin Co., Chicago, Ill., is now Research Spectroscopist with the Ford Motor Co., Dearborn Engine Plant, Dearborn, Mich.

**M. Antoinette Falcone,** until recently with the Associated Merchandising Corp., has been appointed Associate Director, Textile Lab., Good Housekeeping Inst., New York City.

**Richard A. Flinn,** Assistant Chief Metallurgist in American Brake Shoe Co.'s Research and Development Center, has accepted an Associate Professorship of Product Engineering and Metallurgical Engineering at the University of Michigan.

**Clinton Grove,** formerly with the Staso Milling Co., Bound Brook, N. J., is now affiliated with the Central Commercial Co., Northfield, Ill.

**Victor Hicks** recently was appointed Chief Physicist of Tracerlab, Inc., Boston, Mass. Prior to joining Tracerlab, Dr. Hicks was employed at Ansco, Binghamton, N. Y. He also has worked for Westinghouse X-Ray Co., Long Island City, N. Y., Westinghouse Research Labs., East Pittsburgh, Pa., and taught at the University of Pittsburgh. From 1941 to 1946 he served in the Bureau of Ordnance, Navy Dept., Washington, D. C. At Tracerlab he will be responsible for over-all direction of the many physical research and development projects now being carried on by that corporation, including several important government projects.

**Charles F. Hauck** is now associated with Blaw-Knox Construction Co., Pittsburgh, Pa., as Manager, Sales Promotion, Chemical Plants Div. He was previously with Hall Labs., Inc., Pittsburgh.

**Lloyd R. Jackson,** until recently Research Supervisor, has been named an Assistant Director of Battelle Institute, Columbus, Ohio. Known particularly for his work on the engineering properties of materials, he will handle research coordination. The new assistant directorship, according to Director Clyde Williams, results from the increasing demand by industry and government for Battelle research. Mr. Jackson has been associated with much of Battelle's research on fatigue, creep, plastic flow, and structural analysis, and is author of many technical papers.

**J. W. Jordan** is now Manager of Research Laboratories in the new office and laboratories building of National Lead Co. in Houston, Tex. He was formerly serving as a senior fellow of the industrial fellowship sponsored by the Baroid Sales Division of National Lead at Mellon Institute.

**Paul E. LaValley** is now Research Engineer U. S. Rubber Reclaiming Co., Inc., Buffalo, N. Y.

**Wesley Minnis** has been named Director Research & Development, National Aniline Div., Allied Chemical and Dye Corp., New York City. Until recently he had been Assistant Director, Research & Development, at the National Aniline Buffalo plant.

**Harry W. Moses,** formerly Civil Engineer, U. S. Bureau of Reclamation, Stockton, Calif., is now with the U. S. Dept. of the Interior, Third Departmental Engineering Management Training Program, Washington, D. C.

**Horace G. Oliver, Jr.,** is now with the U. S. Army, as Lt. Col., Management Office, Office of the Chief of Ordnance, Ordnance Corps, Fort Myer, Arlington, Va. Until recently he was associated with The M. W. Kellogg Co., Jersey City, N. J., as Engineer, Special Projects Dept.

**M. Rea Paul,** for many years associated with the National Lead Co., and more recently with Frederic H. Rahr, Inc., color consultants, New York City, has accepted appointment as Vice-President of The Eagle-Picher Sales Co. He will be in charge of the Company's Washington (D.C.) Office, and will direct its government contacts. During World War II Mr. Paul was Chief of the Protective Coatings Bureau of the War Production Board; Deputy Director, Research and Development Div., Synthetic Rubber Production; and served as Chief of Operations and Contracting Officer of the Smaller War Plants Corporation. A long-time member of ASTM, he will continue his activities as Chairman of Committee E-12 on Appearance, also participation in the work of Committee D-1 on Paint where he has served since 1930 as an officer and member of many of the subgroups.

**Fredrick A. Petersen** has accepted appointment as an Associate with Hunter-Associates, Business Association Management, Cleveland, Ohio. For the past ten

years Mr. Petersen has been located at the University of Illinois, Dept. of Ceramic Engineering, and has been closely associated with the porcelain enamel industry.

**Harry W. Pierce** has been elected Vice-President of the New York Shipbuilding Corp., Camden, N. J. Joining the corporation in 1930, after serving as Naval Constructor, U. S. Navy, Mr. Pierce became Assistant to the President in 1947, most of his work through the years being connected with welding in ship construction. During World War II, he handled several projects for the Bureau of Ships, Navy Dept., receiving the Certificate of Commendation from the Bureau. He also administered the landing craft construction program for New York Shipbuilding Corp., during World War II.

**Raymond J. Rosenberger,** formerly Specification Writer, Gannett, Fleming, Corddry & Carpenter, Inc., Harrisburg, Pa., is now with J. E. Greiner Co., Baltimore, Md., in the capacity of Engineer of Specifications.

On December 1, after many years of service with the Socony-Vacuum Oil Co., New York City, **E. A. Snyder,** Specialist on Electrical Insulating Oils, Chemical Products Div., Lubricating Dept., retired. Active in various phases of ASTM work, perhaps his most notable contribution was his long-time chairmanship of Subcommittee IV on Liquid Insulation which functions as one of the main groups of Committee D-9 on Electrical Insulating Materials. Under his guidance this committee has had an intensive research and standardization program, also has arranged several interesting symposiums and discussions on testing and evaluation of insulating oils.

Through the years Mr. Snyder has contributed notably to the work of the New York District Council, of which he has been a long-time member. Mr. Snyder has another distinction: he is one of the two or three living ASTM members who were privileged to be associated with the Society's first President, Dr. Charles B. Dudley, in the Pennsylvania Railroad's laboratory at Altoona. "Ed"'s plans for the immediate future include a trip to the West Coast, to spend some time with his son.

**Samuel O. Sorensen** has been elected to to the board of directors of Archer-Daniels-Midland Co., Minneapolis, Minn. Joining ADM as a chemist in 1923, Mr. Sorensen served successively during the following years as Chief Chemist, Technical Director, and in 1947 was named Vice-President in Charge of Research. In ASTM Mr. Sorensen has rendered valued service on Committee D-1 on Paint, Varnish, Lacquer, and Related Products, especially in its subgroups concerned with drying oils and volatile solvents for organic protective coatings. He also serves on the Technical Coordinating Committee of the Paint Industry, representing the American Oil Chemists Society.

**Theodore A. Venia,** formerly Textile Technologist, Cantor-Greenspan Co., Inc., is now associated with the American Raw Silk Corp., Ft. Worth, Tex., as Textile Consultant.

# NEW MEMBERS...

*The following 47 members were elected from September 25, to November 14, 1951, making the total membership 7100 . . . Welcome to ASTM*

Note—Names are arranged alphabetically—company members first, then individuals.

### Chicago District

ARMSTRONG, G. LESLIE, Chief Chemist, U. S. Reduction Co., 4610 Melville, East Chicago, Ind.

COLLINS, FREDERICK V., Chief Engineer, Precision Paper Tube Co., 2035 W. Charleston St., Chicago 47, Ill.

DEMER, L. J., Research Fellow, University of Minnesota, Engineering Experimental Station, Minneapolis 14, Minn.

HAUS, JAMES J., Chemist, Box 15, Nashua, Iowa. [J]*

* [J] denotes Junior Member.

SEIDMAN, MARTIN, Research Chemist, The Visking Corp., 6733 W. Sixty-fifth St., Chicago 38, Ill.

SNOW, FRED A., Co., C. A. Snow, 942 W. Kinzie St., Chicago 22, Ill.

### Detroit District

KELLER TOOL Co., William M. Booth, Test Engineer, Grand Haven, Mich.

HOOD, STANLEY R., Vice-President, Chicago Development Corp., Riverdale, Md. For mail: 4805 Charing Cross Rd., Birmingham, Mich.

HUNT, FRED B., Chief, Laboratories Div., Detroit Arsenal, Center Line, Mich.

### New England District

LEISTER, FAYETTE, Vice-President, Engineering, The Fafnir Bearing Co., New Britain, Conn. For mail: 244 Wooster St., New Britain, Conn.

SPENCER, ERNEST L., Associate Professor of Civil Engineering, Northeastern University, 360 Huntington Ave., Boston 15, Mass.

### New York District

FEDERAL BEARINGS Co., INC., F. W. Racknagel, Chief Engineer, Poughkeepsie, N. Y.

BAVA, VINCENT, Quality Control Supervisor, The W. L. Maxson Corp., 460 W. Thirty-fourth St., New York 1, N. Y.

TREACY, C. S., Vice-President and Chemical Director, Mamaroneck Chemical Corp., 442 Waverly Ave., Mamaroneck, N. Y.

### Ohio Valley District

COMSTOCK, PHILIP D., General Superintendent and Engineer, Ohio River Sand Co., Inc., 129 River Rd., Louisville 2, Ky.

OHIO NORTHERN UNIVERSITY, COLLEGE OF ENGINEERING, Ada, Ohio.

### Philadelphia District

CHAUNDY, LESTER E., JR., Vice-President, National Precision Casting Corp., 322 E. Berkley St., Clifton Heights, Pa.

CORDDRY, W. H., Vice-President, Gannett Fleming Corddry & Carpenter, Inc., 600 N. Second St., Harrisburg, Pa.

### Pittsburgh District

FARNHAM, F. R., Chief Engineer, Gibson Electric Co., 8350 Frankstown Ave., Pittsburgh 21, Pa.

MARTIN, E. H., JR., Manager, Building Insulation Sales, Pittsburgh Corning Corp., 307 Fourth Ave., Pittsburgh 22, Pa.

POLK, WILLIAM H., Sales Engineer, Pittsburgh Corning Corp., 307 Fourth Ave., Pittsburgh 22, Pa.

SINGER, SIDNEY L., Chief Chemist, Falk and Co., Box 1030, Pittsburgh, Pa. For mail: 5509 Jackson Ave., Pittsburgh 6, Pa.

### St. Louis District

BRUCE Co., E. L., Frank H. Lyons, Research Director, Box 397, Memphis, Tenn.

MEXICO REFRACTORIES Co., Charles A. Smith, Vice-President and Chief Engineer, Box 267, Mexico, Mo.

MINERAL PRODUCTS Co., THE, R. G. Hardy, Chief Engineer, 3801 Kaw Dr., Kansas City, Kan.

WIRE ROPE CORPORATION OF AMERICA, INC., J. E. Josendale, Vice-President, Box 229, St. Joseph, Mo.

### Southern California District

DISKANT, EUGENE, M., Research Chemist, Department of Water and Power, City of Los Angeles, Box 3669, Terminal Annex, Los Angeles 54, Calif.

SINES, GEORGE H., Assistant Engineer, University of California, Engineering Dept., Los Angeles 24, Calif.

### Washington District

BRODE, WALLACE R., Associate Director, National Bureau of Standards, Washington 25, D. C.

WRIGHT, MARCELLUS, JR., Partner, Marcellus Wright and Con, Architects, 100 E. Main St., Richmond 19, Va.

### Western New York-Ontario District

KING, W. J., Works Laboratory Supervisor, Canadian General Electric Co., Ltd., 94 Lansdowne Ave., Toronto 5, Ont., Canada.

### U. S. and Possessions

SHEFFIELD STEEL CORP., Kenneth P. Campbell, Superintendent of Metallurgy, Box 3129, Houston 1, Tex.

HUSS, V. R., President, Florida Testing Laboratories, 806 S. Success Ave., Lakeland, Fla.

MILLER, CHARLES M., Chief Design Engineer, Brown & Root, Inc., 943 E. Sixty-first St., Shreveport, La.

SHERMAN, O. R., Manager, Houston Branch, Pittsburgh Testing Laboratory, 41[illegible] Dennis St., Houston 4, Tex.

### Other than U. S. Possessions

ESTABLECIMIENTOS METALURGICOS "IM DAC" S. A., Francisco Agurto M., President, Casilla 7001, Santiago, Chile.

GENERAL MOTORS SOUTH AFRICAN, LTD., Cecil R. Rogers, Production Facilities Engineer, Box 1137, Port Elizabeth, South Africa.

BAPTISTA DE SOUZA, ELECTO, Technologist, Chemical Dept., Brazilian Navy, Corpo de Fuzileiros Navais, Ilha das Cobras, Rio de Janeiro, Brazil.

BIBLIOTECA DEL MINISTERIO DE MARINA, Casilla de Correos 3193, Buenos Aires, Argentina.

BIBLIOTECA DEL MINISTERIO DE MARINA, Casilla de Correos 3193, Buenos Aires, Argentina.

BIBLIOTECA DEL MINISTERIO DE MARINA, Casilla de Correos 3193, Buenos Aires, Argentina.

BIBLIOTECA DEL MINISTERIO DE MARINA, Casilla de Correos 3193, Buenos Aires, Argentina.

CONSELHO NACIONAL DE PETROLEO, Av. Treze de Maio, 13–26 andar, Rio de Janeiro, Brazil.

INOUE, CHIKAYUKI, General Manager, Sany[illegible] Pulp Co., Ltd., Iwakuni Mill, 2800 Mur[illegible]noki, Iwakuni-Shi, Yamagichi-Ken, Japan.

SAWWAF, ZAFER A., Teacher, Syrian University, Chemistry Dept., Damascus, Syria. For mail: Mohajirine, Mohandes St., Damascus, Syria. [J]

TREVINO-GOMEZ, ROBERTO, Manufacturer's Representative, Apartado Postal 76[illegible] Monterrey, N. L., Mexico.

WELLINGER, KARL, Professor, Technische Hochschule, Stuttgart, Germany. For mail: Cannstatterstr. 212, Stuttgart, Germany.

## NECROLOGY...

*The deaths of the following members have been reported*

J. K. Findley, Metallurgical Engineer, legheny-Ludlum Steel Corp., Dunkirk, Y., (July 6, 1951). Member since 1943, d for many years an active member of mmittee A-10 on Iron-Chromium, Iron-romium-Nickel and Related Alloys, ving at the time of his death on its Ad-sory group, and as Chairman of Sub-mmittee VIII on Specifications for rought Products.

Meyer Hirschthal, Consulting Engi-er, Hirschthal & King, New York, Y. (Oct. 15, 1951). Active in ASTM chnical work for many years, Mr. rschthal represented the American Rail-y Engineering Assn. on a number of im-rtant groups. He served on ASA Sec-nal Committees on Specifications and ethods of Test for Hydraulic Cements, d on Specifications for Sieves for Testing rposes. He also served on the Joint mmittee on Concrete and Reinforced ncrete, and was an active and long-time mber of Committee C-1 on Cement, d of C-9 on Concrete and Concrete gregates.

Victor A. Ryan, Director of Research, Crown Cork & Seal Co., Baltimore, Md. (Sept. 20, 1951). An active worker in several ASTM technical groups, Mr. Ryan had been associated with Crown Cork & Seal since 1936, prior to which he had been on the technical staffs of the Durium Products Co. and the Irvington Varnish and Insulator Co. More recently he had been a member of the Section on Laboratory Evaluation of Cutting Fluids of Committee D-2 on Petroleum Products. In his earlier connections he served as a member of Committee D-9 on Electrical Insulating Materials and several of its subgroups, also on Committee D-13 on Textile Materials.

Howard R. Staley, at the time of decease was Construction Engineer, U. S. Atomic Energy Commission, Silver Spring, Md.; and for 15 years prior to January, 1951, Professor on the Staff of the Department of Building Engineering and Construction, Massachusetts Institute of Technology, Cambridge, Mass. (Aug. 23, 1951). Affiliated with ASTM since 1938, Professor Staley was associated in his work at MIT with a number of other active ASTM members. A graduate of MIT, he had been connected with the construction business in Iowa before pursuing his studies at the Institute. Recognized as an outstanding consultant in the field of design and construction related to buildings, he had participated actively through the years in many of the ASTM cementitious groups. He was a member of the New England District Council 1949–1951. In addition to his ASTM affiliation he was an active member of the American Concrete Institute, and of the American Society of Civil Engineers.

Calvin Sterling, Head, Analytical Section, International Nickel Co., Inc., Research Lab., Bayonne, N. J. (Oct. 1, 1951). Associated with the International Nickel Co. since his graduation from Pennsylvania State College in 1925, Mr. Sterling had taken an active interest in the advancement of technical development of standard methods of metallurgical analysis widely used throughout the country. Affiliated with ASTM since 1937, he participated actively through the years in the work of Committee E-3 on Chemical Analysis of Metals, occupying at the time of his death a number of important posts on the editorial and advisory groups, and the subgroups on ferrous and non-ferrous metals, copper, and photometric methods. He also had represented his company for many years on Committee B-4 on Electrical Heating, Resistance, and Related Alloys.

William L. Sullivan, Chemical Engineer, Westinghouse Electric Corp., Lamp. Div., Bloomfield, N. J. (April 23, 1951). Member since 1948.

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### lendar of Other Society Events

*ong" and "Short" calendar will appear in altere Bulletins. The "short" calendar notes meets in the few immediate weeks ahead—the "long" endar for months ahead.*

erican Chemical Society—December 27–28, Christmas Symposium on "Nuclea-ion," Evanston, Ill.

erican Chemical Society—January 12, 1952, 4th Annual Delaware Chemical Symposium, University of Delaware, Newark, Del.

ciety of Plastics Engineers, Inc.—January 16–18, Eighth Annual National Technical Conference, Edgewater Beach Hotel, Chicago, Ill.

erican Road Builders' Association—January 21–24, 50th Anniversary Annual Meeting, Houston, Tex.

erican Institute of Electrical En-gineers—January 21–25, Winter General Meeting, Hotel Statler, New York, N. Y.

stitute of the Aeronautical Sci-ences—January 28–February 1, 20th Annual Meeting, Hotel Astor, New York, N. Y.

ter-Society Color Council—February 7–9, Annual Meeting, Hotel Statler, New York, N. Y.

erican Institute of Mining & Metal-lurgical Engineers—February 18–21, Annual Meeting, Hotel Statler, New York, N. Y.

erican Society of Civil Engineers—March 5–7, Spring Convention, New Orleans, La.

tional Association of Corrosion En-gineers—March 10–14, Annual Conference and Exhibition, Buccaneer and Galvez Hotels, Galveston, Tex.

erican Railway Engineering Associa-tion—March 11–13, Annual Meeting, Palmer House, Chicago, Ill.

e Society of the Plastics Industry, Inc.—March 11–14, National Plastics Exposition, Convention Hall, Philadelphia, Pa.

### 1951 Chicago Building Code and Index

A copy of the 1951 Chicago Building Code and Index has recently been received. This edition has been prepared with many attractive features including a long-wearing cover desirable for constant everyday reference and careful arrangement of subject matter for convenient use. The edition represents as completely as possible the recently revised ordinances covering building construction in the city of Chicago.

A very complete index has been prepared to facilitate easy reference to the proper sections. This consists of a general index arranged alphabetically at the beginning of the book with supplementary indexes at the beginning of each chapter.

In line with the trend of modern building codes toward the use of performance type standards, various aspects are found in the book with analyses by recognized authorities in the industry. Nationally recognized standards are referred to throughout the book, including many ASTM Standards applicable to building materials.

Alphabetical listings are found in the back of the book of licensed electrical, mason, and plumbing contractors, located in Cook County and the immediate vicinity.

The book is being published by the Index Publishing Corporation, 100 N. LaSalle St., Chicago 2, Ill. Copies of this book are available from the publisher at a nominal price.

### Allen V. Astin Succeeds E. V. Condon at NBS

Allen V. Astin, a Government scientist associated with the development of proximity fuses in World War I, has been appointed acting director of the National Bureau of Standards to succeed E. V. Condon. Dr. Astin, who has been specializing in research for the Defense Department, was Associate Director of NBS and was responsible for the division of electricity, electronics, ordnance development, missile development, and the office of basic instrumentation, and for coordination of NBS operations with other Government agencies. A graduate of the University of Utah, he has been with the Bureau for many years.

### Malleable Iron—Then and Now

An article entitled "Malleable Iron—Then and Now" is a feature of the October issue of *Foundry* magazine, in which it is pointed out that in 1826, 125 years ago, in Newark, N. J., Seth Boyden, trying to make white-heart malleable, produced instead an improved iron which came to be known as "American Malleable Iron." Throughout the article, prepared by James H. Lansing, Technical Director of Malleable Founders' Society, and Secretary of ASTM Committee A-7, there are many references and excerpts from the widely used ASTM standards covering various types and classes of malleable iron castings.

## NEWS NOTES ON

# Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses.

### Catalogs and Literature

**Load Cells**—Engineering Data Folders are now available that describe and illustrate the application of Atcotran Torsion Bar Load Cells and Cantilever Beam Load Cells. These cells measure force in tension or compression, thrust, torque, weighing, etc. They change a mechanical force into a linear electrical signal to be fed into servo recorders and indicators. They are used in: dynamometers, engine test stands, bolt ring torque measurements on propeller hubs, low-capacity stress analysis for materials testing machines. The Torsion Bar Load Cell is available in ranges from 5 to 500 lb. Folders describe operation features, range data, wiring diagrams, and case dimensions.

*Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Pa.*

**Concrete Testing Machine**—Baldwin concrete testing machines of 100,000 lb capacity are presented in a new 2-page Bulletin No. 327. The bulletin covers features, including hydraulic loading, independent hydraulic load weighing, accessories, and specifications.

*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

**Analytical Balance**—A new brochure featuring the Sartorius "Selecta" direct-reading analytical balance is now available. The instrument may be read directly to 1/10 mg without the use of a vernier.

*C. A. Brinkmann Co., P. O. Box 532, Great Neck, L. I., N. Y.*

**Laboratory Supplies**—Now available is the Fall edition of "Cenco News Chats," published by the Central Scientific Co. Artwork and feature articles are devoted to textiles and related subjects, with the major articles being devoted to the work of the American Association of Textile Chemists and Colorists. Among the pieces of laboratory equipment described are: microscopes, photomicrography with the Polaroid Land Camera, thermoconductivity equipment, and equipment for electrochemical analysis.

*Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.*

**Photoelastic Stress Analysis**—Eastman Kodak has now completely revised and brought up to date its standard publication, "Photoelastic Stress Analysis." It discusses briefly other methods of stress analysis and then launches into a discussion of the principles of photoelasticity. This section covers polarized light, double refraction or birefringence, isochromatic lines, isoclinic lines, circular polarization, and stress patterns. The booklet then discusses apparatus for the production of photoelastic stress analysis including light sources, filters, polarizers, analyzers, quarter-wave plates, condensers, and the camera. Materials which are suitable for making models of the object or part to be tested are discussed and the actual making of the models and factors that should be considered are covered. Models for three-dimensional stress analysis are also discussed. Photographic materials for use in the process, exposure and processing, and a list of manufacturers who make equipment for use in photoelastic stress analysis are also covered in the publication. Finally, there is a bibliography of books and articles on the subject. The form is on sale through Kodak dealers.

*Eastman Kodak Co., Rochester 4, N. Y.*

**Continuously Adjustable Auto-Transformers**—A recently published 8-page brochure describes and fully illustrates with engineering drawings and cutaway views the General Radio line of "Variac" continuously variable auto-transformers for voltage, power, speed, and heat control.

*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

**Wenner Potentiometers**—To describe the design and construction features of high-precision Wenner Potentiometers, Leeds & Northrup Co. has just published a newly revised, 16-page catalog, "Wenner Potentiometers"—Catalog EH22(2). The publication discusses both the low-range instrument—used primarily for precision measurement of thermocouple voltages—and the high-range, or standardizing potentiometer, used for accurate voltage measurement up to 1.9111 v. It also traces the circuit development of each potentiometer from the basic Wenner principle. External and internal illustrations of the potentiometers are given, annotated to indicate special construction features. Listing and illustration of recommended accessory equipment is also given.

*Leeds & Northrup Co., 4394 Stenton Ave., Philadelphia 44, Pa.*

**Care and Use of the Microscope**—A new edition of "The Microscope—Its Application, Use and Care" is now being distributed by E. Leitz, Inc., New York. The Pocket-size booket is intended to serve as a preliminary introduction to the use and care of the microscope and not as a substitute for textbooks or exhaustive manuals on the subject. Compiled by E. G. Keller, and other Leitz microscope experts, the new 48-page handbook is packed with basic facts every user should know, plus up-to-date information on the significant changes in microscope design which have been made in recent years.

*E. Leitz, Inc., 304 Hudson St., New York 13, N. Y.*

**Ultraviolet Generator**—A brochure de-scribes the various features and models of the Menlo "Fluoretor," a portable single unit ultraviolet generator, fluorescence tester, and comparator combined. Specifications list the materials and design details which permit the unit to be used in broad daylight. Four types are cataloged: the 2537-Angstrom battery-operated model, the 2537-Angstrom 115-v model, the 3650-63-Angstrom battery-operated model, and the 3650-63-Angstrom 115-v model. Also included are a full listing and description of the six sample holders and the Neoprene cone viewing accessory which makes possible the viewing the large surfaces with daylight excluded. Details are given on registration, guarantees, and operating costs.

*Menlo Research Lab., Box 522, Menlo Park, Calif.*

**3000 kg Proving Rings**—A recently published 2-page brochure describes the 3000 kg proving rings manufactured by Morehouse Machine Co. for calibrating Brinell hardness testers. Sections on design, operation, and specifications are included.

*Morehouse Machine Co., 233 W. Market St., York, Pa.*

**Universal Testing Machines**—Vol. No. 1 of "Tinius Talks," published by Tinius Olsen Testing Machine Co. is devoted to the "Super L" Universal Testing Machine, Load Cells, the Olsen Automatic Balancing Machine, and low magnification stress-strain recording. The second article, dealing informally with load cells, emphasizes the value of strictly adhering to the test methods set down by ASTM.

*Tinius Olsen Testing Machine Co., Easton Rd., Willow Grove, Pa.*

**Laboratory Supplies**—The Fall edition of "Scientific Apparatus and Methods" published by E. H. Sargent and Co. is now available. Covered in the scientific methods is the use of the Sargent mercury cathode vessel. Apparatus covered includes Van Slyke Apparatus, Kahn Shaker and the Carius Furnace.

*E. H. Sargent and Co., 4647 W. Foster Ave., Chicago, Ill.*

### Instrument Notes

**Laboratory Carrier Amplifier**—Designed for making low-level measurements from transducers of stress, strain, displacement, pressure, temperature, velocity, acceleration, and other parameters, a new carrier amplifier is intended for engineering, physical, medical, and other dynamic investigations. High-gain characteristics are combined with low noise. Operating stability is said to be achieved under

erse conditions of local electrical disurbance, as well as temperature and umidity variations. To permit flexibility f use, the equipment is housed in units which can be either mounted in standard 9-in. racks or bench-stacked.

*Electronic Engineering Associates, Ltd., 100 Brittan Ave., San Carlos, Calif.*

**Constant Temperature Bath**—Precise ontrol of water-bath temperatures in an rder never before attained, is said to be rovided by the new Fisher "Isotemp ath." The constancy of bath temperaure claimed for the new bath is ±0.005 C. This constancy is of particular importance or laboratory work in making viscosity or ensity measurements. A complete degn change from conventional water bath mploys an electronic circuit to control a 00-w and an 800-w heater. Also, the eating elements, stirrer, and controls are ontained in a central column with all onnections made through the bottom of he 15 by 15-in. Pyrex brand glass bath—hus providing an unobstructed top surace for inserting samples. Stirring is ffected by a 1150-rpm motor and proellers so that the entire 10-gallon water or light mineral oil) content is conantly in motion.

*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

**Carboypump**—A new pump is said to ffer a safe, practical method for dispensg a large variety of solvents, acids and kalies, and liquid organic materials from ass, rubber, and metal containers. The ensity of the liquid has no effect because he pump operates on the positive displacement principle. Heavier viscosity fluids re handled as readily although at a slower umping rate. The manufacturer lists as atures: (1) Safe, practical dispensing of orrosive liquids from large containers. 2) Prevents contamination as the pump is ft in container until the container is npty with the only material coming in ontact with the liquids either Pyrex or eflon. (3) Eliminates the hazards always resent when carboys are tipped or andled. (4) Eliminates the hazards of scharged vapors or pressure sprays when r pressure is used to remove liquids from rge containers. (5) Eliminates purchasg of small unit bottles of corrosive quids.

*Laboratory Industries, Inc., Chicago 39, Ill.*

**Separatory Funnels**—It is announced hat "Squibb" type separatory funnels ith delivery stems of larger inside diameer are being produced by Kimble Glass, ivision of Owens-Illinois Glass Co. The rger diameter of the stem permits the olumn of liquid in the stem to break and rain after the stopcock is shut off, thus cilitating recovery of the liquid in the em. It is not necessary to empty the nnel and then open the stopcock to obin this volume. Quantitative separaons are said to be more easily and cometely obtained.

*Owens-Illinois Glass Co., Box 1035, Toledo 1, Ohio.*

**Oscillograph Camera**—Called "The Osllo-Drum Camera," a new product is innded to supply a means of studying very pid, nonrepetitive oscillographic traces. full size (1:1 reproduction) recording ith a time base expanded to the linear ngth of the drum circumference, is proiced by this camera either on paper, for onomy and quick processing, or on film. he size of the recording is large enough for practical study of slopes and other characteristics of the trace under observation. In operation, the camera photographs the screen of a single- or multiple-beam oscilloscope tube, set for deflection along one axis only. The image of the screen trace is focused by a lens on the surface of the continuously rotating drum to which the sensitized paper or film is attached.

*Photographic Analysis Co., 582 E. 7th St., Brooklyn 18, N. Y.*

**Heating Tape**—A new flexible heating tape for small glass vessels of standard or odd shape—such as distilling or fractionating columns—has been announced. The chief advantage claimed for this tape (designed to operate at "black heat") is the fact that it produces high wattages without excessive heating of the wire. Being well below the glow point, this is said to eliminate the danger of fire in the presence of inflammables. The tape consists of resistance wire covered with a double insulating sheath of white braided fiberglas yarn. Flexible Heating Tapes are available in three standard lengths—2 ft, 4 ft, and 6 ft. (Wattage: 115, 190, and 275, respectively.) The standard width is $\frac{1}{2}$ in., but any width from $\frac{1}{4}$ in. to 2 in. is available.

*Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.*

**New Strain Tester**—Scott Testers, Inc., Providence, R. I., announce that they are now producing a Strain Tester which performs elongation tests on rubber and other high elastomers in accordance with methods developed by the National Bureau of Standards. The instrument was initially developed by the Bureau of Standards, and subsequently modified by Scott Testers, Inc.

The outstanding advantage of the new Scott Strain Tester is stated to be its unusual method of additive weight loading, which is simple and positive. Selection of the additive weights is accomplished mechanically, without the use of electrical circuits, which are said to be unsatisfactory under the climatic conditions common to rubber-producing areas. The operator gages the specimen for thickness, then turns the additive weight control hand wheels so that the numbers appearing in front of the pointer are numerically the same as those observed on the thickness gage. The additive weight control hand wheels turn the shafts which rotate the additive weight trays by chain and sprocket drive. This positions the correct combination of weights over the pins of the additive weight holder.

There are four sets of additive weights, a set for each stress range: 50, 100, 200, or 400 psi. These are arranged in numbered positions in trays, with clear and positive identification assuring proper arrangement. Each set consists of 18 additive weights arranged in the two circular trays in the base of the machine and a fixed weight positioned separately, below the additive weight trays.

The test performed by this instrument is the standard test for determination of strain expressed as a percentage of the original sample gage length under known and constant unit stress. Samples of uniform width and length are die-cut from the sheet of material to be tested. Upon the sample is superimposed a gage length of 10 cm by means of visible markings. The sample is then stressed by loading with fixed additive weights as previously described, to produce unit values of 50, 100, 200, or 400 psi. Thus loaded, the sample is suspended in a free static condition for a sufficient period of time to permit satisfactory dimensional stability to be reached.

*Scott Testers, Inc., 120 Blackstone St., Providence, R. I.*

**Force-Balance Controller**—A new, non-indicating, force-balance controller with only one-knob adjustment for two control responses has recently been introduced by the Taylor Instruments Cos. The Transet Bi-Act Controller, as it is called, is designed for applications where it is desirable to transmit the measured variable to some remote location. It is particularly adaptable to flow, liquid level, or pressure applications requiring fast reset rates and broad throttling bands, or applications where derivative action is not essential. This new controller is another component part of the Taylor three-part Transet Control System. The controller measures $7\frac{1}{2}$ in. over-all length and has a range of adjustment of 1 to 200 per cent throttling range and automatic reset of 0 to 100 repeats per min.

*Taylor Instrument Cos., Rochester 1, N. Y.*

# INSTRUMENT COMPANY NEWS . . . .

***Announcements, changes in personnel, new plants and locations, and other notes of interest***

**Central Scientific Co.** At the recent meeting of the directors of the Cenco Corp., the parent stockholding company, and the Central Scientific Co. held at 1700 Irving Park Rd., Chicago, John T. Gossett, president of Central Scientific Co., was elected chairman of the board of directors of both companies, succeeding to the responsibilities of the late chairman, E. Perry Holder.

**Hellige, Inc.** Dr. P. A. E. Hellige, president of Hellige, Inc., manufacturer of scientific instruments for medicine, industry, and public health, has announced plans for increased production capacity. The new plant, now under construction on a 10-acre tract on Stewart Ave., Garden City, L. I., N. Y., is expected to start operation in February, 1952. Hellige, Inc. will continue to operate two plants in Long Island City and Mineola, N. Y.

**Macbeth Corp., Newburgh, N. Y.** Mr. Carl E. Foss, color consultant of Princeton, N. J., was elected a director of the Macbeth Corp., Newburgh, N. Y., manufacturers of scientific apparatus and color control equipment, at a stockholders' meeting recently. Mr. Foss is at present color consultant to the Sherwin-Williams Co. and their allied companies; also color consultant to the Wyandotte Chemical Co. and the Container Corp. of America. Mr. Foss is president of the Munsell Color Co. of Baltimore, Md.

# Preservation of the Declaration of Independence and the Constitution of the United States


## By Gordon M. Kline[1]

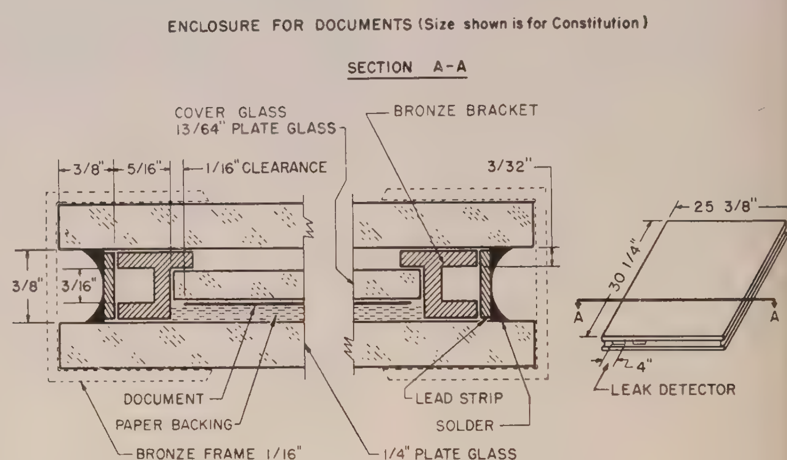

THE Declaration and Constitution are precious and irreplaceable documents whose preservation for an indefinite number of centuries is vital. Even harmful effects that appear only slowly or to a slight extent become important. Hence the Library of Congress requested the National Bureau of Standards to determine the best means of preserving the sheepskin parchments on which these historical statements are inscribed. An important proviso in this assignment was that these revered documents should continue to be on display to the American people in the Shrine at the Library of Congress.

The Declaration of Independence, dating from July 4, 1776, is engrossed on one sheet of parchment. It has been on display during most of its 175 years and the ink has faded badly and partly chipped off. A wet process was employed in 1823 to make a reproduction, which contributed further to the deterioration of the document. On the other hand, the Constitution of the United States, dating from Sept. 17, 1787, has fared better. The five sheets of parchment, upon which it and the resolution of transmittal are inscribed, were never exhibited until 1924 when they were placed in the Shrine at the Library of Congress. The ink is intact and distinct and the parchments are relatively free from yellowing and streaking; there has been some insect attack at the edges.

After consideration of the various factors which lead to the deterioration of the protein base of the parchments, the National Bureau of Standards decided to enclose the documents within sealed receptacles filled with helium, an inert gas. This protects the documents against chemically active gases such as oxygen and sulfur dioxide, insects and microorganisms, and contamination with dirt or corrosive substances.

Research conducted in the NBS Leather Section indicated that the appropriate relative humidity of the helium should be between 25 and 35 per cent at room temperature. Too little moisture leads to brittleness and cracking of the parchment; large amounts of moisture produce damaging hydrolytic reactions and are conducive to the growth of bacteria that do not require air for reproduction. The desired humidity was achieved by passing the helium through distilled water maintained at a temperature of 4 to 6 C. Sheets of pure cellulose were made from cotton rags in the NBS experimental paper mill to back up the documents and to serve as a humidity reservoir to offset any changes in the water-vapor content of the atmosphere in the enclosure resulting from temperature variation.

Double -glazed panels made commercially as insulating "picture" windo under the trade name "Thermopan by the Libbey-Owens-Ford Glass were selected for the enclosures. Th consist of two panes of tempered pla glass separated ⅜ in. by lead str which are hermetically soldered to special metallic coating applied to glass. The cooperation of the ma facturer in supplying the enclosures a services of their technical personnel




**Section Sketch of the Glass Enclosure Used for the Preservation of the Declaration Independence and the Constitution. The backing paper and cover glass position document, the bronze bracket separates the glass plates from the assembly, and the l strip soldered to the glass plate completely seals the document from the outside atm phere.**

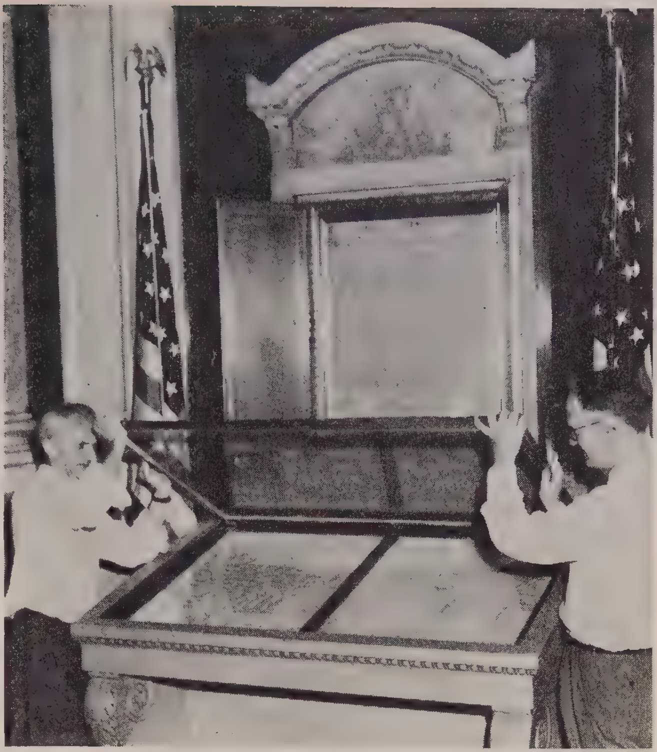
**In the First Step of the Sealing of the Declaration of Independence the Parchment Special Backing Paper Are Centered on One Panel of the Thermopane Enclosure. to right: Dr. G. M. Kline, Chief, Organic and Fibrous Materials Division, Natio Bureau of Standards; Mr. A. W. Kremer, Keeper of the Collections, Library of Congre Dr. L. H. Evans, Librarian of Congress.**

[1] Chief, Organic and Fibrous Division, National Bureau of Standards, Washington, D. C.

he sealing operations is gratefully acknowledged.

A leak detector small enough to be built permanently and unobtrusively into the enclosure and simple enough to permit tests to be made readily without moving the enclosures from the Shrine was an essential item in view of the indefinite duration of the storage period. A thermal-conductivity type of gas analyzer was developed for this purpose by Mr. E. C. Creitz of the NBS Gas Chemistry Section and constructed by the NBS Electron Tubes Section. An electrical current passing through a platinum spiral causes it to increase in temperature, with a corresponding increase in electrical resistance; this increase is greater in air than in helium which has a thermal conductivity approximately six times that of air. The needle of an ammeter in the leak detector unit moves to read zero when the platinum spiral is in helium and 100 when it is in air.

One of the important causes of deterioration of documents is light radiation which induces chemical breakdown of the parchments and inks. Studies of deterioration of irradiated cellulose by the NBS Paper Section show that although the greatest damage is caused by ultraviolet energy of wave lengths shorter than 360 m$\mu$, damage is still appreciable for wave lengths up to 500 m$\mu$. This includes all of the violet and blue part of the visible spectrum. The energy in the ultraviolet part of the spectrum is also known to be the most damaging to proteins that are present in animal parchment.



The Enclosures, Framed by Bronze Channels Gold-Plated by the NBS Electrodeposition Section, Are Placed in the Shrine at the Library of Congress. The Declaration of Independence is in the upper case and two sheets of the Constitution are in the lower case. Both cover doors contain the laminated glass filters to protect the documents against harmful light radiation.

he inner bronze bracket and outer frames ere gold-plated by August Zejda, NBS Electrodeposition Station.

A filter, consisting of a laminated glass made with a yellow cellulose acetate plastic interlayer, was devised by Mr. R. P. Teele, Jr., of the NBS Photometry and Colorimetry Section to remove ultraviolet radiation and the blue-violet wave lengths of the visible spectrum. The Eastman Kodak Co. supplied the large cellulose acetate sheets, similar in optical properties to a Wratten 4 filter, and the American Window Glass Co. prepared the laminates. One such filter was placed in the cover door of the Shrine and another directly in front of the spotlight. This double filtration makes it possible to direct on the Shrine a greater amount of light useful in viewing the documents.

The combination of this new method of mounting the Declaration of Independence and the Constitution in helium-filled glass enclosures and the improved lighting conditions at the Shrine has provided the desired protection for these parchments and at the same time has served to give the American public a better view of these historic documents than ever before.

The Declaration of Independence and the Constitution of the United States were placed on exhibition in their new enclosures at the Library of Congress on Constitution Day, Sept. 17, 1951, in a ceremony that included addresses by President Truman and Chief Justice Vinson. For an excellent account of the travels of the Constitution, see "The Constitution of the United States Together with an Account of Its Travels Since September 17, 1787," by David C. Mearns and Vernon W. Clapp, The Library of Congress, Washington, 1948 (printed by the Government Printing Office and available from the Superintendent of Documents, Washington 25, D. C., 15 cents a copy). A similar publication pertaining to the Declaration of Independence is "The Story of a Parchment," by David C. Mearns, The Library of Congress, Washington 25, D. C., 1950. Further details regarding the studies at the National Bureau of Standards leading to this new method for the preservation of documents will be found in NBS Circular 505 entitled "Preservation of the Declaration of Independence and the Constitution of the United States," 1951, for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 15 cents.

# BOOK REVIEWS...

## Strength of Materials

THIS book, coauthored by Glen N. Cox, Professor of Hydraulics and Mechanics, New York University, and Frank J. Germano and John H. Bateman, Professor of Engineering Mechanics and of Civil Engineering, Louisiana State University, respectively, presents an elementary text for use by engineering students in the first course of strength of materials, presupposing completion of the course in statics. As stated by the authors, it was written as an attempt to offer a clearer presentation of those topics in strength of materials which they, as educators, had found that students have difficulty in assimilating. Extensive library research was conducted to assure compatibility of the treatment of such topics as riveted connections, column action, repeated stress, and stress concentration, with laboratory experience; and latest building codes were consulted in order to bring the material into conformance therewith. The text contains 500 practical problems of graded difficulty, with some solved for better demonstration of principles, and others presented for solution by the students. There are numerous figures and photographs. The book includes fourteen topical chapters and two appendices: (A) covering "Moment-Distribution Method for Continuous Beams," and (B) presenting seven tables relating to physical properties of common metals and structural timber, and the elements of I-Beam sections, channels, equal-leg and unequal-leg angles.

This 408-page publication is available from Pitman Publishing Corp., 2 W. 45th St., New York 19, N. Y., at a cost of $5.50.

## Corrosion Guide

ONE of the most recent books on corrosion is the 629-page "Corrosion Guide" by Erich Rabald, Director and Chief Chemist of the C. F. Boehringer & Sohne G.m.b.H., Mannheim-Waldhof, Germany, the English translation of which is published by The Elsevier Publishing Co.

Corrosion and its causes interest the chemical plant engineer mainly to the extent that he wishes to avoid it. Rabald shows in his "Corrosion Guide" *how* to avoid corrosion by answering the needs of chemical *practice*. Some 40 pages of text present a general introduction to the choice of materials for the avoidance of corrosion, general principles of corrosion, and measurement of corrosion resistance.

The book contains over 500 pages of tabular data which catalogs a collection of methods with their advantages and deficiencies. Corrosive phenomena data are presented for 40 important construction materials when used in conjunction with more than 250 corrosive agents. Some corrosive agents are discussed in a few lines while other subjects such as acetic acid cover 6 or 8 pages. The construction materials include 23 metals, acid-resisting, linings, plastics, enamel, glass, porcelain, stone, textiles, and wood.

The Bibliography includes nearly 300 sources including 57 books.

It might be pointed out that the physical property values given are in metric units rather than English and the extent of corrosion attack is given in grams per square meter per day rather than the usual grams per square decimeter.

## Statistical Methods for Chemists

THIS book by W. J. Youden, Statistician, National Bureau of Standards, is written, as the author observes in the preface, for those who make measurements and interpret experiments. Characterized by an absence of statistical theory and proofs, it makes available to the scientist the modern statistical system of units for expressing scientific conclusions. The author's 20 years' experience in experimentation has led him to write from the laboratory man's point of view, the statistical techniques outlined being those which he found most useful in a wide variety of scientific investigations. Dr. Youden combines the modern concept of experimental design with the associated techniques for the interpretation of data, using examples based on actual data from real investigations. It is his feeling (again quoting from the preface) that "when senior workers, who are responsible for the direction of investigations, realize the possible gains from useful experimental arrangements they will encourage younger men to go more fully into the subject of experimental design."

Dr. Youden is a member of ASTM and active in several of its technical groups particularly Committee E-11 on Quality Control of Materials. He is the author of many technical papers, a number of which have been presented at ASTM meetings.

The 126-page book, containing over 60 tables, sells for $3, and is published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.

## Machinability—Lower Costs

A VOLUME entitled "Increased Production-Reduced Costs Through a Better Understanding of the Machining Process and Control of Materials Tools Machines," the second published by Curtiss-Wright Corp. in connection with the Machinability Research Program sponsored by the United States Air Force Air Materiel Command, concentrates on the effect of the microstructures of plain-carbon, alloy, and stainless steels on tool life. The twelve steels selected for testing represent widely used industrial types and by correlating the microstructure of any of hundreds of other steels, satisfactory estimates of cutting conditions can be made.

The data are arranged in handbook fashion for ready reference and the book contains numerous illustrations.

## Reagent Chemicals

A VALUABLE recent additi to the ASTM library is the 406-page v ume on "Reagent Chemicals" contain 177 American Chemical Society specif tions for analytical reagents. Twenty-fi of these specifications are entirely n while many of the remaining 153 have b extensively revised.

In establishing the present specificati for reagent chemicals, the Ameri Chemical Society's Committee on Anal cal Reagents has painstakingly explo the needs of the analyst, while keepin mind the problems of the manufacture reagent chemicals. Accordingly, the sp fications represent requirements that adequate, but not so severe as to resul excessive production costs.

Suitable procedures are provided determining compliance of each reag with the requirements prescribed in specifications. It has been pointed that the checking of the purity of reag by users, according to these procedure an invaluable aid in assuring best res in analytical work.

With the increasing recognition of value of the ACS specifications as sta ards for purity of reagent chemicals, it become current practice to specify t whenever possible, reagents used in AS chemical methods shall conform to ACS specifications. Users of AS methods will, therefore, find this boo particular interest.

Copies of this publication in a dur cloth binding, clearly printed on g paper, are available at $5 a copy from special Publications Department, Am can Chemical Society, 1155 Sixteenth N. W., Washington 6, D. C.

## Errata

WE HAVE been advised an error appears in Fig. 7 of the paper Test of a Prestressed Concrete Beam," Finley, Morrison, and Ragan which pears in the October ASTM BULLE page 64. The scale for Unit Stress, should be multiplied by 1000.

IN THE paper on " Measurement of the Dynamic Modulu Elastomers by a Vector Subtrac Method," by G. W. Painter, which pears on page 45 of the October AS BULLETIN, three errors have been covered. First of all, the author's ini are "G. W."

On page 46, Eq 1 should read:

$$F_t = \sqrt{(F_s)^2 + (F_d)^2}$$

In the right-hand column on page last line of the first paragraph sh read:

Resilience, per cent $= 100 \times e^{-\pi G''/G}$

# Tests of Fine Aggregate for Organic Impurities and Compressive Strength in Mortars

By Bryant Mather[1]

Synopsis

This paper sets forth the results of a study of methods used in testing fine aggregate for concrete to determine the presence of organic impurities and the relations between the results of color tests, mortar-strength tests, and certain other factors such as soundness and grading. Data are given on 294 samples of fine aggregate.

This study was con-
ĉted at the Concrete Research Divi-
n, Waterways Experiment Station, as
part of the Corps of Engineers, Civil
orks Investigations Program, in ac-
rdance with authority provided by the
fice, Chief of Engineers. The tests
re performed by M. Vaquer and R. L.
arry under the supervision of H. K.
ok and T. B. Kennedy.

## ASTM Methods

The ASTM Standard Method of Test
: Organic Impurities in Sands for
ncrete (C 40 – 48)[2] states in section 1,
'his method of test covers the pro-
dure for an approximate determination
the presence of injurious organic com-
unds in natural sands which are to
used in cement mortar or concrete.
e principal value of the test is to fur-
h a warning that further tests of the
ds are necessary before they are ap-
oved for use." The method then de-
ibes a procedure by which a selected
nple of the sand is subjected to the
tion of a 3 per cent solution of sodium
droxide for 24 hr and a procedure for
eparing a "Reference Standard Color
lution" with which the color of the
ution over the test sample may be
mpared. The method states that solu-
ns darker in color than the reference
andard have a "color value" higher
an 500 ppm in terms of tannic acid.
e previous edition of the method,
opted in 1933 and in effect until 1948,
ovided for the making of a compari-
 between the color of the liquid above
 sample and the colors given in Figs.
o 5 on a color plate accompanying the
thod. The color plate comparison
s used in all the work described
rein. Figures 1 and 2 in the color
ate represent sands suitable for use in
ncrete, and Figs. 3, 4, and 5 represent
ds which should never be used in
ncrete. The method does not state what additional tests should be performed once the "warning" has been obtained that such further tests are necessary. However, the ASTM Standard Method of Test for Measuring Mortar-Making Properties of Fine Aggregate (C 87 – 47)[3] states in section 1: "This method of test covers the procedure for measuring the mortar-making properties of fine aggregate for concrete by means of a compression test on specimens made from a mortar of plastic consistency and gaged to a definite water-cement ratio. Its principal use is intended for the determination of the effect of organic impurities revealed by the colorimetric test." Section 2 of the ASTM Standard Specifications for Concrete Aggregates (C 33 – 49)[4] requires that fine aggregate be subjected to the test for organic impurities and any sample producing a color darker than the standard shall be rejected unless, when tested for mortar strength in accordance with ASTM Method C 87, the mortar develops a compressive strength of not less than a specified percentage of that developed by the standard mortar. Section 5 of the specifications, however, provides that the fine aggregate shall be of such quality that

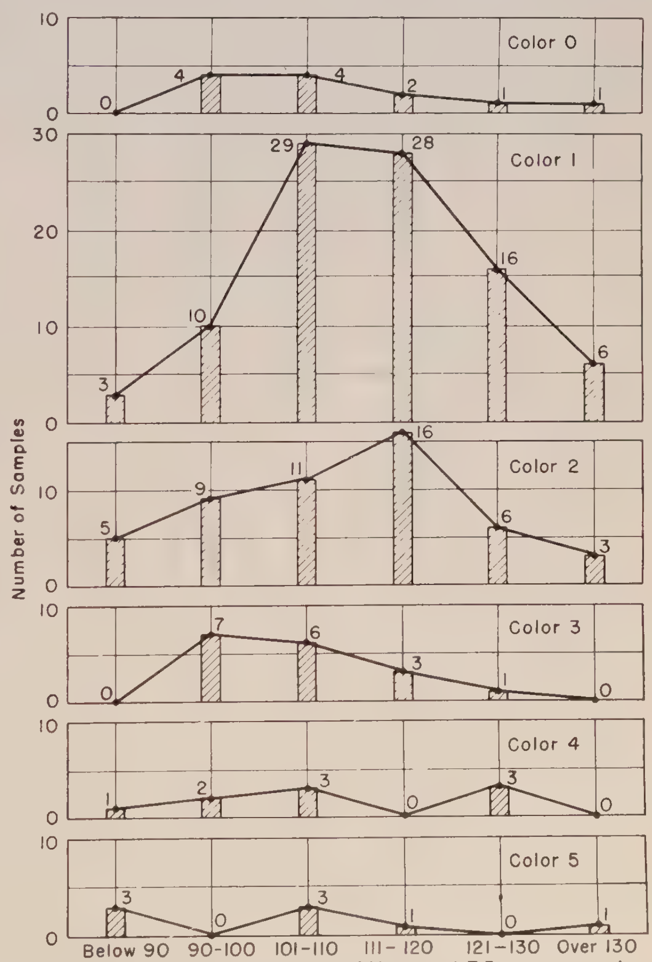



Fig. 1.—Relation of Relative Compressive Strength of Mortar to Results of Color Test for Organic Impurities in Sand.

[1] Civil Engineer, Concrete Research Division, Waterways Experiment Station, Corps of Engineers, U. S. Army, Jackson, Miss.

[2] 1949 Book of ASTM Standards, Part 3, p. .

[3] 1949 Book of ASTM Standards, Part 3, p. 754.

[4] 1949 Book of ASTM Standards, Part 3, p. 715.

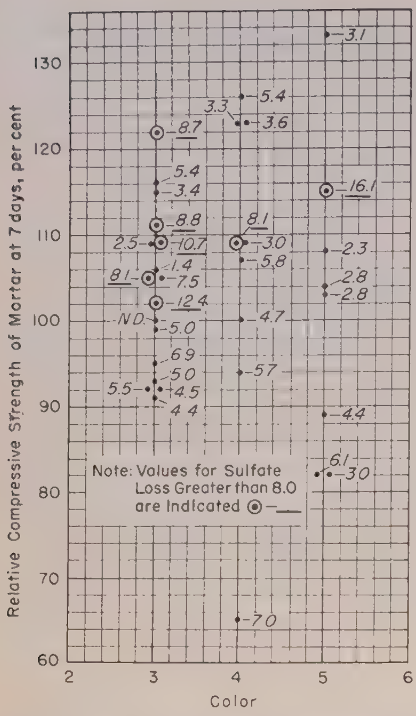



Fig. 2.—Relation of Relative Compressive Strength of Mortar to Results of Soundness Test for Sand, for Sands Showing Values of Three or Higher in the Color Test.

when tested by Method C 87 the compressive strength will not be less than a specified percentage of that developed by the standard mortar. It appears, therefore, that even though Method C 87 has been recognized to have as its principal value the checking of the significance of tests for organic matter performed in accordance with Method C 40, mortar-strength tests will nevertheless be made on all samples, presumably as a measure of "quality."

## Literature

Considerable literature has accumulated concerning the mortar-strength test for sands (ASTM Method C 87). The test was thoroughly discussed in 1943 by F. H. Jackson (**1**)[5] and, more recently, it has been discussed by Harold S. Sweet (**2**). Both Jackson and Sweet find that the test has many points of weakness and involves many difficulties of interpretation. Jackson, however, was of the opinion that the method possessed sufficient fundamental advantages to warrant further study. Investigations of the variables affecting the results of tests using ASTM Method C 87 were made at the laboratories of the National Sand and Gravel Assn. and the National Ready-Mixed Concrete As… The results of these investigations … contained in a paper by Delmar … Bloem (**3**) in which it is concluded th…

"ASTM Method C 87 does not prov… adequately for the isolation of the pr… cipal variable which it is intended … measure, that is, the effect of organic i… purities on the strength of mortars. Ch… acteristics of the sand such as fineness a… probably shape and surface texture aff… the quantity of sand required in the t… which in turn appears to bear a direct … lationship to strength. Also, a wide ra… in relative strength of mortars is found … result from the use of different blends … cement. It is possible, therefore, tha… sand might fail to meet specification … quirements with one cement but give … tirely acceptable results with another." …

## Test Data and Analysis

It has been the practice of the Co… crete Research Division, Waterwa… Experiment Station, to perform te… in accordance with ASTM Method C … for organic impurities on natural sa… samples and to perform tests in acco… ance with ASTM Method C 87 for m… tar strength on all samples of fine … gregate, both natural and manufactur… Table I shows results of tests on 294 f… aggregate samples, of which 187 w… natural and 107 manufactured.

[5] The boldface numbers in parentheses r… to the list of references appended to this pape…

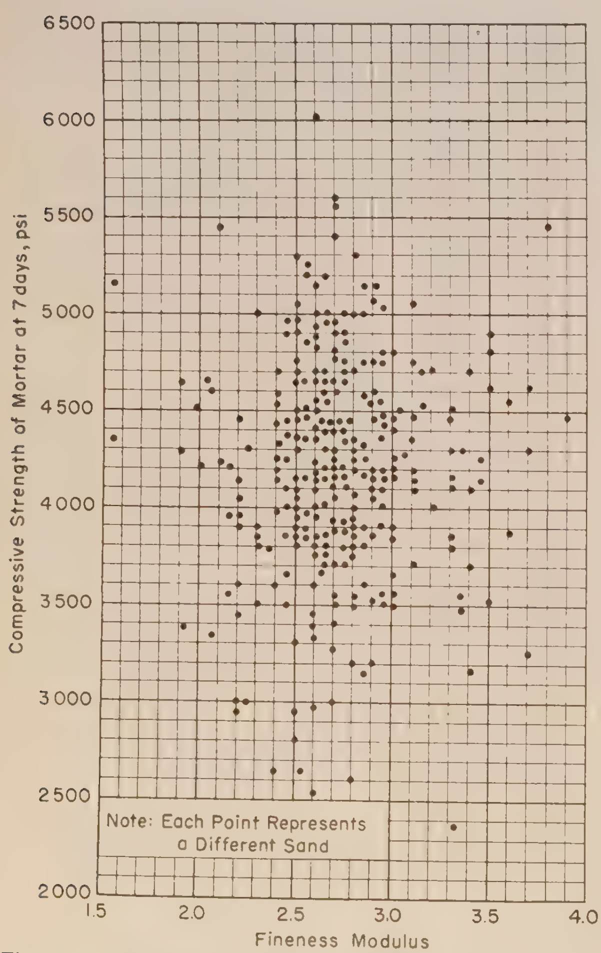



Fig. 3.—Relation of Compressive Strength of Mortar to Fineness Modulus of Sand.

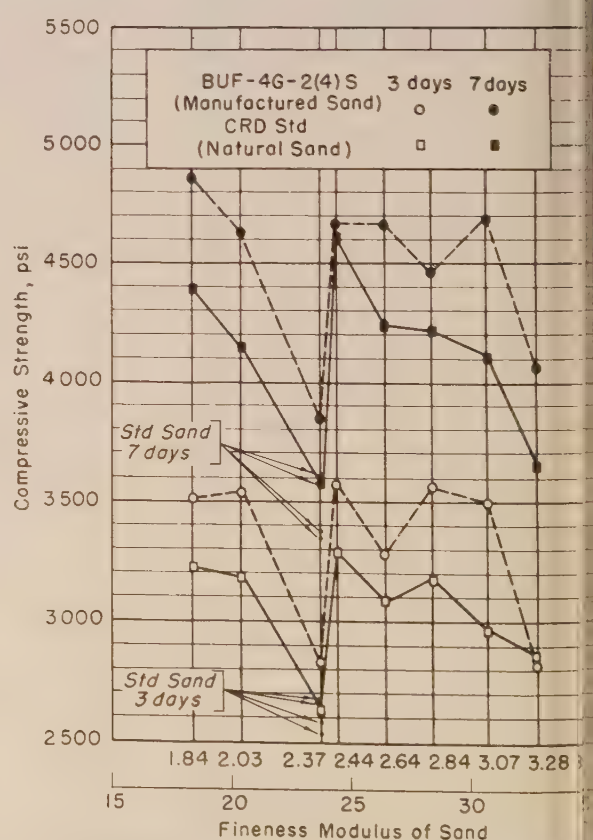



Fig. 4.—Relation of 3- and 7-Day Compressive Strength … Mortar to Fineness Modulus of Two Sands.

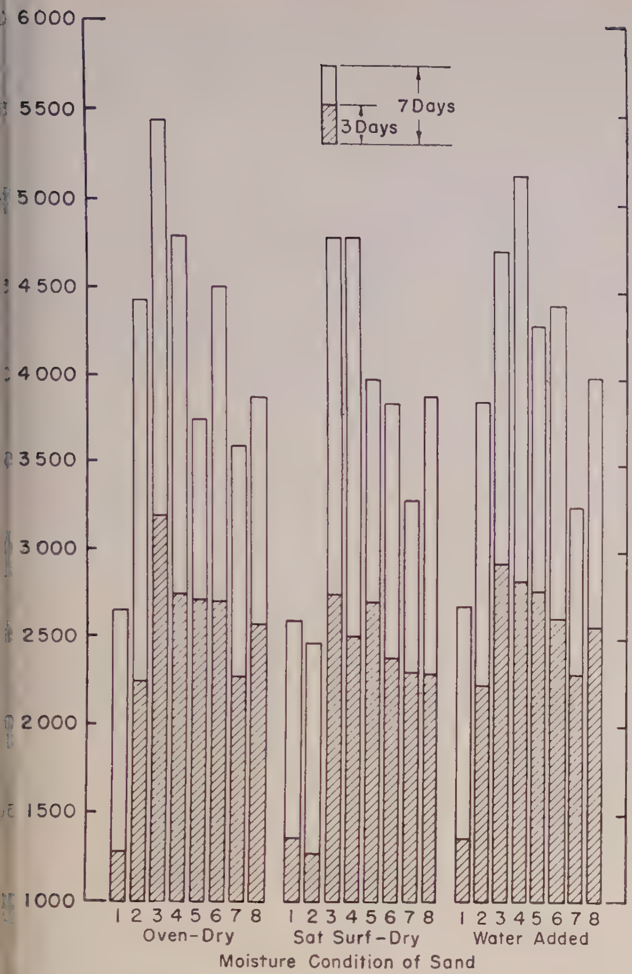



Fig. 5.—Relation of 3- and 7-Day Compressive Strength of Mortar to Moisture Condition of Sand.

It is doubtful if the 1 per cent increase in ratio from 3 to 7 days for natural and the 1 per cent decrease for manufactured fine aggregate samples should be regarded as significant. It is, however, noted that 51 per cent of the manufactured sand samples showed a higher ratio at 7 than 3 days in spite of the slight decline of the average, and that 58 per cent of the natural sand samples showed an increase in ratio between 3 and 7 days

*Relation of Strength and Color:*

Examination of Table I reveals that, of the 188 samples of sand tested by Method C 40, only 34 showed colors three, four, or five (17 showed color three, 9 showed color four, and 8 color five) and of these 34 samples, only 4 showed a strength ratio at 7 days of less than 90 per cent. One sample which showed color five had a strength ratio at 7 days of 133 per cent. It is believed that the 4 samples which showed colors of three or higher and strength ratios less than 90 almost certainly represented materials that would be undesirable for use as fine aggregate in concrete. It is difficult, however, to draw any conclusions from these data alone concerning the suitability of the 8 samples which showed colors one and two but strengths less than 90 per cent, or the 30 samples which showed colors higher than two but strengths higher than 90 per cent. These relationships are shown in Fig. 1.

*Relation of Color and Soundness:*

The 34 samples which showed colors of three or higher were examined with respect to soundness as determined by the magnesium sulfate test, Method CRD-C 115 – 49.[6] Seven of these samples showed magnesium sulfate losses in excess of 8 per cent; however, none of the 4 samples which showed high color and less than 90 per cent strength is among these 7. The 4 samples showing high color and low strength had losses in the magnesium sulfate soundness test of 3.0, 4.4, 6.1, and 7.0 (see Fig. 2). The sample which showed color five and 133 per cent strength had a magnesium sulfate loss of 3.1 per cent, as is also shown by Fig. 2.

*Relation of Strength and Grading:*

The test for compressive strength of mortar is required to be performed with the use of mortars of constant water-cement ratio. It might be expected, therefore, that compressive-strength results should not show any consistent variation as a function of factors known to affect strength primarily by affecting water demand. Figure 3 shows the apparent absence of relationship between strength of mortar and the fineness modulus of the sand used in making the mortar when data for a large number of sands of differing gradings are considered. A somewhat different indication appears when a single sand is investigated in a variety of artificially prepared gradings. One natural and one manufactured sand were selected, separated by sieving, and recombined to obtain the several gradations studied. The results of these studies are indicated graphically in Fig. 4 and are tabulated in Table III.

*…rength Ratio:*

…Mortar-strength ratio data at 3 and …days are given in Table I for 288 of the …4 samples listed; of these 288 samples, …2 are natural and 106 are manufac…red fine aggregate. The arithmetic …ans of the strength ratios are given …low:

| | Number of Samples | Mean Strength Ratio, per cent | |
|---|---|---|---|
| | | 3-Day | 7-Day |
| …nufactured . | 106 | 117 | 116 |
| …tural . . . . . . . | 182 | 108 | 109 |

…e significantly lower mean strength …ios at both ages for the natural ma…ials as compared with the manufac…ed ones may be interpreted in at …st two ways: (1) the suite of na…al materials included in this study …s, on the average, of lower "quality" … measured by this test than was the …up of manufactured materials, or (2) … comparison of compressive strengths …mortars made with Ottawa sand and …rtars made with natural sands may … expected to approach equality more …sely than a comparison with mortars …de with manufactured materials.

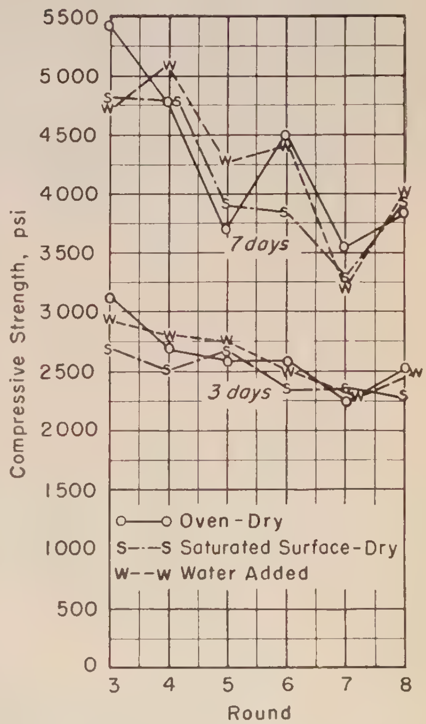



Fig. 6.—Relation of 3- and 7-Day Compressive Strength of Mortar to Moisture Condition of Sand.

[6] Waterways Experiment Station, "Method of Test for Soundness of Aggregates by Use of Magnesium Sulfate" (CRD-C 115-49) (based on ASTM Designation C 88 – 46 T), Handbook for Concrete and Cement, Vicksburg, Miss., August, 1949.

TABLE I.—TEST DATA ON FINE AGGREGATES.



| CRD No. | Source | Organic Color, Fig. | Type | Strength Per Cent 3 Day | Strength Per Cent 7 Day | Compressive Strength, psi 3 Day | Compressive Strength, psi 7 Day | Flow % | Sand lb | Sieve Analysis Individual % Retained 4 | 8 | 16 | 30 | 50 | 100 | 200 | Pan | F.M. | Sp Gr | Abs % | MgSO4 Loss % | Date Rec'd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BA-1 S-1 | Vestal, N. Y. | 1 | Nat. | 104 | 104 | 2854 | 4433 | 95 | 3.53 | 3.4 | 18.4 | 10.9 | 18.0 | 33.8 | 10.8 | 3.1 | 1.6 | 2.88 | 2.63 | 1.2 | 10.1 | 7-31-47 |
| BUF-4 G-1(2)(S) | Leroy, N. Y. | --- | Mfg. | 122 | 109 | 2650 | 3500 | 96 | 2.46 | 2.2 | 27.0 | 24.0 | 13.5 | 8.8 | 5.1 | 4.6 | 14.8 | 3.07 | 2.63 | 1.0 | 4.5 | 10-27-47 |
| BUF-4 G-2(2)(S) | Leroy, N. Y. | --- | Mfg. | 123 | 122 | 2550 | 3386 | 100 | 2.93 | 0.0 | 7.4 | 16.6 | 28.7 | 26.8 | 14.8 | 4.0 | 1.7 | 2.58 | 2.63 | 1.3 | 3.5 | 10-27-47 |
| BUF-4 G-3(2)(S) | Stafford, N. Y. | --- | Mfg. | 110 | 101 | 2238 | 2806 | 100 | 3.27 | 0.0 | 6.2 | 16.5 | 30.2 | 25.4 | 14.2 | 4.0 | 3.5 | 2.53 | 2.64 | 1.3 | 3.0 | 10-27-47 |
| BUF-4 G-30(S) | Depew, N. Y. | --- | Mfg. | 94 | 109 | 1900 | 3021 | 98 | 3.17 | 0.5 | 7.9 | 17.9 | 31.3 | 24.0 | 12.4 | 3.7 | 2.3 | 2.68 | 2.66 | 1.6 | 3.4 | 10-27-47 |
| BUF-4 S-1 | Rochester, N. Y. | 1 | Nat. | 100 | 121 | 2883 | 4650 | 100 | 2.31 | 0.6 | 3.2 | 7.1 | 15.1 | 37.1 | 24.1 | 8.4 | 4.4 | 1.92 | 2.66 | 0.9 | 21.7 | 8- 1-47 |
| BUF-4 S-2 | Canawaugus, N. Y. | 0 | Nat. | 105 | 111 | 3017 | 4267 | 95 | 3.07 | 4.6 | 20.4 | 20.9 | 32.2 | 16.2 | 2.9 | 1.1 | 1.7 | 3.45 | 2.64 | 2.5 | 23.4 | 8- 7-47 |
| BUF-4 S-2(2) | Mt. Morris, N. Y. | 1 | Nat. | 92 | 93 | 2967 | 4167 | 94 | 2.97 | 4.0 | 14.7 | 11.3 | 13.8 | 33.3 | 16.8 | 4.6 | 1.5 | 2.68 | 2.61 | 1.9 | 10.5 | 11- 3-47 |
| BUF-4 S-9(2) | Boonville, N. Y. | 1 | Nat. | 103 | 109 | 3033 | 4833 | 100 | 3.12 | 3.1 | 11.1 | 16.9 | 25.8 | 29.0 | 10.3 | 2.9 | 0.9 | 2.87 | 2.64 | 0.7 | 5.6 | 11- 3-47 |
| BUF-4 S-10(2) | Allegany, N. Y. | 0 | Nat. | Combined with BUF-4 S-15(2) for Cubes | | | | | | 0.0 | 0.5 | 1.1 | 5.8 | 47.3 | 37.4 | 6.5 | 1.4 | 1.56 | 2.59 | 2.0 | 8.4 | 11- 3-47 |
| BUF-4 S-12(2) | Buffalo, N. Y. | 1 | Nat. | 95 | 104 | 2817 | 4650 | 97 | 3.25 | 2.0 | 9.9 | 13.7 | 16.0 | 33.9 | 20.8 | 3.1 | 0.6 | 2.53 | 2.62 | 1.3 | 3.8 | 11- 3-47 |
| BUF-4 S-15(2) | Franklinville, N. Y. | 0 | Nat. | 117 | 104 | 2550 | 3556 | 96 | 3.13 | 0.5 | 14.9 | 20.0 | 24.9 | 28.9 | 8.1 | 1.8 | 0.9 | 2.98 | 2.62 | 1.3 | 8.7 | 11- 3-47 |
| BUF-4 S-17 | Lancaster, N. Y. | 0 | Nat. | 111 | 114 | 3450 | 5075 | 101 | 3.20 | 3.2 | 17.7 | 11.4 | 17.3 | 30.7 | 13.8 | 4.7 | 1.2 | 2.80 | 2.69 | 1.4 | 9.5 | 11- 3-47 |
| BUF-4 S-18 | Mt. Morris, N. Y. | 1 | Nat. | 109 | 106 | 2383 | 3558 | 102 | 2.89 | 7.8 | 6.6 | 10.4 | 16.6 | 35.7 | 18.3 | 3.2 | 1.4 | 2.66 | 2.60 | 2.0 | 14.2 | 11- 3-47 |
| CRD G-3(S) | Little Rock, Ark. | 1 | Mfg. | 105 | 113 | 2283 | 4050 | 101 | 2.87 | 0.2 | 7.8 | 15.1 | 34.2 | 23.5 | 13.9 | 2.3 | 3.0 | 2.64 | 2.61 | 1.7 | 4.2 | 2-25-47 |
| CRD G-4(S) | Alton, Ill. | 0 | Mfg. | 110 | 110 | 3358 | 4592 | 102 | 3.37 | 1.3 | 11.9 | 12.8 | 29.5 | 24.3 | 13.3 | 4.2 | 2.7 | 2.69 | 2.67 | 1.1 | 3.6 | 2-27-47 |
| CRD G-6(S) | Hinton, W. Va. | 0 | Mfg. | 121 | 105 | 3479 | 4700 | 102 | 3.21 | 0.3 | 17.9 | 41.6 | 20.3 | 8.6 | 4.5 | 2.1 | 4.7 | 3.40 | 2.70 | 0.5 | 3.2 | 3-31-47 |
| CRD G-7(S) | Jamestown, Ky. | --- | Mfg. | 128 | 105 | 3144 | 4200 | 100 | 1.89 | 0.0 | 20.7 | 20.3 | 15.3 | 14.0 | 9.1 | 8.1 | 12.5 | 2.68 | 2.67 | 0.8 | 3.7 | 4-17-47 |
| CRD G-8(S) | Celina, Tenn. | --- | Mfg. | 105 | 110 | 2688 | 4408 | 101 | 2.30 | 1.1 | 17.8 | 25.0 | 15.5 | 9.7 | 6.9 | 5.7 | 18.3 | 2.68 | 2.64 | 1.3 | 2.5 | 4-17-47 |
| CRD G-9(S) | Lancaster, Tenn. | --- | Mfg. | 116 | 103 | 2858 | 4117 | 100 | 2.89 | 0.0 | 10.1 | 32.9 | 20.8 | 12.1 | 6.4 | 5.2 | 12.5 | 2.75 | 2.69 | 1.0 | 3.9 | 4-17-47 |
| FTP-1 S-1 | Minot, N. D. | 2 | Nat. | 25% (107 | 107 | 2450 | 4350 | 101 | 3.74 | 0.0 | 0.3 | 0.3 | 0.9 | 58.5 | 32.6 | 5.6 | 1.8 | 1.55 | 2.62 | 1.0 | 25%( -- | 3- 3-47 |
| FTP-1 S-2 | Minot, N. D. | 4 | Nat. | 75% (--- | 107 | 2450 | 4350 | 101 | 3.74 | 1.8 | 8.5 | 23.5 | 38.0 | 21.4 | 4.8 | 0.6 | 0.4 | 3.09 | 2.62 | 1.4 | 75%(5.8 | 3- 3-47 |
| FTP-2 S-1 | Miles City, Mont. | 5 | Nat. | 127 | 133 | 2500 | 5075 | 95 | 3.59 | 22.4 | 7.7 | 5.4 | 5.6 | 19.4 | 31.1 | 6.8 | 1.6 | 2.95 | 2.63 | 0.9 | 3.1 | 3-24-47 |
| FTP-2 S-2 | Miles City, Mont. | 2 | Nat. | 122 | 103 | 2400 | 3950 | 102 | 4.17 | 34.7 | 8.7 | 9.5 | 14.2 | 23.4 | 7.5 | 1.2 | 0.8 | 4.12 | 2.56 | 1.6 | 8.6 | 3-24-47 |
| FTP-2 S-3 | Laurel, Mont. | 1 | Nat. | 119 | 108 | 2350 | 4133 | 102 | 3.38 | 12.6 | 18.5 | 12.3 | 16.8 | 25.0 | 9.8 | 2.0 | 3.0 | 3.28 | 2.61 | 0.9 | 5.0 | 3-24-47 |
| FTP-3 S-1 | Hot Springs, S. D. | 2 | Nat. | 121 | 108 | 2525 | 3483 | 98 | 2.31 | 5.0 | 8.5 | 13.3 | 21.1 | 31.2 | 14.6 | 4.9 | 1.4 | 2.66 | 2.60 | 1.3 | 13.1 | 9- 2-47 |
| GAL-1 S-1 | Columbus, Tex. | 1 | Nat. | 102 | 105 | 1933 | 4117 | 98 | 4.06 | 7.8 | 21.0 | 17.7 | 21.1 | 21.5 | 7.9 | 1.9 | 1.1 | 3.37 | 2.60 | 0.6 | 3.0 | 2-18-47 |
| GAL-1 S-2 | Texarkana, Tex. | 2 | Nat. | 143 | 118 | 2600 | 4617 | 100 | 3.93 | 3.1 | 9.5 | 11.0 | 18.5 | 37.7 | 11.5 | 7.7 | 0.8 | 3.53 | 2.62 | 0.4 | 2.9 | 2-18-47 |
| GAL-1 S-3 | Minden, La. | 1 | Nat. | 128 | 132 | 2433 | 5150 | 100 | 3.87 | 2.8 | 11.4 | 10.2 | 15.6 | 44.4 | 12.0 | 3.4 | 0.2 | 2.62 | 2.62 | 0.3 | 3.2 | 2-18-47 |
| GAL-1 S-4 | Romayor, Tex. | 1 | Nat. | 130 | 126 | 2456 | 4917 | 95 | 3.82 | 0.3 | 4.2 | 9.8 | 20.0 | 57.7 | 7.0 | 0.9 | 0.1 | 2.45 | 2.63 | 0.3 | 2.5 | 2-18-47 |
| KAN-4 S-2 | Harlan County, Nebr. | 2 | Nat. | 91 | 86 | 2617 | 3833 | 101 | 2.88 | 4.0 | 6.2 | 13.9 | 27.0 | 30.2 | 8.4 | 5.9 | 4.4 | 2.63 | 2.58 | 0.7 | 4.3 | 10-17-47 |
| LR-1 G-53(A)(S) | Bull Shoals Mt., Ark. | 1 | Mfg. | 131 | 111 | 2717 | 5417 | 96 | 3.29 | 0.5 | 11.8 | 12.2 | 32.1 | 25.2 | 11.2 | 5.4 | 1.6 | 2.69 | 2.68 | 2.4 | 16.6 | 1-20-47 |
| LR-1 G-53(B)(S) | Bull Shoals Mt., Ark. | 1 | Mfg. | 141 | 109 | 2917 | 5283 | 100 | 3.29 | 0.6 | 13.0 | 12.7 | 34.9 | 21.5 | 11.9 | 4.9 | 0.5 | 2.79 | 2.75 | 1.3 | 8.6 | 1-20-47 |
| LR-1 G-53(C)(S) | Bull Shoals Mt., Ark. | 1 | Mfg. | 149 | 103 | 3092 | 5017 | 98 | 3.08 | 0.5 | 10.7 | 18.3 | 35.0 | 26.5 | 7.5 | 1.0 | 0.5 | 2.82 | 2.66 | 2.8 | 15.7 | 1-20-47 |
| LR-1 G-58(A)(S) | Kingdon Springs, Ark. | 0 | Mfg. | 94 | 103 | 2492 | 4175 | 95 | 1.93 | 0.1 | 8.7 | 14.2 | 30.4 | 26.5 | 14.0 | 4.0 | 2.1 | 2.59 | 2.75 | 1.3 | 4.6 | 4-11-47 |
| LR-1 G-58(B)(S) | Kingdon Springs, Ark. | 0 | Mfg. | 93 | 98 | 2459 | 3992 | 95 | 1.38 | 0.3 | 9.4 | 4.2 | 28.3 | 24.3 | 14.6 | 6.1 | 2.8 | 2.53 | 2.74 | 1.5 | 3.7 | 4-11-47 |
| LR-1 G-59(A)(S) | Guion, Ark. | --- | Mfg. | 104 | 122 | 3072 | 4884 | 100 | 1.87 | 0.0 | 7.9 | 14.6 | 32.3 | 24.2 | 14.5 | 4.8 | 1.7 | 2.57 | 2.67 | 0.8 | 2.3 | 5- 5-47 |
| LR-1 G-59(B)(S) | Guion, Ark. | --- | Mfg. | 89 | 116 | 2612 | 4657 | 103 | 1.63 | 1.8 | 11.5 | 11.7 | 31.1 | 23.7 | 13.7 | 4.1 | 2.4 | 2.70 | 2.67 | 0.6 | 1.9 | 5- 5-47 |
| LR-1 G-60(S) | Guion, Ark. | --- | Mfg. | 92 | 106 | 2514 | 3950 | 96 | 1.50 | 0.0 | 9.0 | 15.0 | 23.5 | 29.1 | 15.7 | 5.9 | 1.8 | 2.49 | 2.67 | 0.8 | 2.0 | 4-29-47 |
| LR-1 G-61(S) | Carthage, Mo. | --- | Mfg. | 107 | 104 | 3150 | 4175 | 102 | 1.60 | 2.0 | 10.7 | 13.6 | 28.3 | 25.8 | 13.8 | 3.9 | 1.9 | 2.70 | 2.62 | 1.1 | 3.6 | 5- 1-47 |
| LR-1 G-62(S) | Harrison, Ark. | --- | Mfg. | 107 | 118 | 3146 | 4725 | 98 | 2.12 | 0.0 | 8.9 | 12.7 | 28.3 | 29.2 | 13.5 | 5.0 | 2.4 | 2.52 | 2.62 | 1.5 | 5.3 | 5- 1-47 |
| LR-1 G-63(S) | Williamsville, Mo. | --- | Mfg. | 107 | 122 | 3146 | 4900 | 101 | 2.36 | 4.3 | 11.8 | 13.9 | 19.1 | 28.4 | 15.7 | 4.7 | 2.1 | 2.70 | 2.62 | 0.3 | 1.8 | 5- 2-47 |
| LR-1 G-64(A)(S) | Flippin, Ark. | --- | Mfg. | 110 | 105 | 2444 | 3517 | 96 | 1.91 | 0.5 | 13.1 | 18.5 | 14.6 | 14.9 | 12.3 | 11.2 | 14.9 | 2.28 | 2.74 | 0.5 | 8.0 | 6-11-47 |
| LR-1 G-64(A & B)(S) | Flippin, Ark. | --- | Mfg. | 120 | 115 | 2680 | 3850 | 100 | 1.81 | 0.3 | 7.3 | 24.5 | 26.1 | 18.2 | 11.2 | 8.0 | 4.4 | 2.62 | 2.71 | 1.3 | 13.1 | 6-11-47 |
| LR-1 G-64(B)(S) | Flippin, Ark. | --- | Mfg. | 135 | 126 | 3017 | 4225 | 102 | 1.73 | 0.3 | 4.2 | 26.9 | 32.1 | 19.1 | 9.4 | 5.1 | 2.9 | 2.74 | 2.69 | 1.6 | 16.1 | 6-11-47 |
| LR-1 G-66(A)(S) | Sylamore, Ark. | --- | Mfg. | 100 | 100 | 2742 | 4246 | 98 | 3.44 | 0.4 | 8.8 | 14.4 | 27.4 | 29.7 | 12.2 | 5.5 | 2.0 | 2.45 | 2.66 | 0.7 | 10.0 | 6-19-47 |
| LR-1 G-66(B)(S) 67(A)(S) | Sylamore, Ark. | --- | Mfg. | 106 | 103 | 2921 | 4379 | 105 | 2.50 | 0.0 | 8.7 | 15.7 | 31.2 | 26.8 | 10.9 | 3.8 | 2.9 | 2.64 | 2.66 | 1.0 | 3.1 | 6-19-47 |
| LR-1 G-67(B)(S) | Sylamore, Ark. | --- | Mfg. | 115 | 104 | 3166 | 4400 | 102 | 2.76 | 0.0 | 8.2 | 16.8 | 31.1 | 24.8 | 12.1 | 4.7 | 2.3 | 2.63 | 2.67 | 0.7 | 5.4 | 6-19-47 |
| LR-1 S-5 | White River, Ark. | 4 | Nat. | 151 | 125 | 2750 | 4642 | 105 | 3.44 | 0.1 | 13.9 | 9.6 | 4.3 | 27.7 | 26.3 | 14.4 | 3.7 | 2.03 | 2.50 | 2.6 | 5.4 | 12-29-46 |
| LR-1 S-6 | White River, Ark. | 3 | Nat. | 134 | 115 | 2458 | 4179 | 102 | 4.41 | 0.1 | 26.1 | 23.2 | 8.8 | 6.4 | 10.6 | 11.2 | 3.6 | 2.94 | 2.50 | 3.0 | 3.4 | 12-29-46 |
| LR-1 S-7 | Crooked Creek, Ark. | 2 | Nat. | 134 | 122 | 2442 | 4431 | 98 | 4.00 | 0.6 | 14.5 | 10.0 | 7.8 | 37.2 | 22.8 | 4.1 | 3.0 | 2.37 | 2.54 | 1.9 | 5.2 | 12-26-46 |
| LR-1 S-8 | Crooked Creek, Ark. | 3 | Nat. | 123 | 116 | 2244 | 4221 | 101 | 3.72 | 0.0 | 13.9 | 9.0 | 5.0 | 36.8 | 20.4 | 13.3 | 1.6 | 2.15 | 2.51 | 2.1 | 5.4 | 12-29-46 |
| LR-1 S-8(3) | Crooked Creek, Ark. | 2 | Nat. | 109 | 98 | 2667 | 4221 | 96 | 1.64 | 0.6 | 4.6 | 3.3 | 6.7 | 58.2 | 25.0 | 1.2 | 0.4 | 2.01 | 2.57 | 1.5 | 6.7 | 5-22-47 |
| LR-1 S-9a | Bull Shoals Mt., Ark. | 1 | Nat. | 95 | 93 | 2367 | 4033 | 100 | 3.66 | 0.8 | 14.2 | 28.4 | 15.7 | 9.0 | 6.8 | 9.3 | 15.8 | 2.61 | 2.66 | 2.7 | 15.4 | 2-10-47 |
| LR-1 S-10 | Bull Shoals Mt., Ark. | 1 | Nat. | 101 | 99 | 2525 | 4300 | 101 | 3.56 | 0.6 | 15.3 | 28.5 | 15.9 | 10.0 | 7.8 | 9.2 | 12.7 | 2.70 | 2.66 | 2.1 | 18.2 | 2-10-47 |
| LR-1 S-11 | Lancaster, Tenn. | 2 | Nat. | 127 | 118 | 2900 | 4767 | 100 | 3.16 | 1.9 | 20.7 | 29.7 | 17.4 | 9.6 | 4.6 | 4.3 | 11.8 | 3.10 | 2.68 | 0.6 | 9.2 | 3- 5-47 |
| LR-4 G-1(S) | Branson, Mo. | --- | Mfg. | 134 | 121 | 2800 | 4192 | 96 | 1.76 | 0.3 | 7.6 | 13.2 | 19.8 | 25.2 | 14.4 | 9.5 | 10.0 | 2.17 | 2.62 | 1.8 | 6.4 | 7-14-47 |
| LR-4 G-2(S) | Branson, Mo. | --- | Mfg. | 124 | 132 | 2584 | 4258 | 102 | 2.11 | 0.0 | 7.4 | 18.6 | 22.8 | 19.5 | 9.8 | 9.6 | 12.3 | 2.29 | 2.61 | 4.2 | 26.7 | 7-14-47 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 2.3 | 7.8 | 11.6 | 28.2 | 40.8 | 8.3 | 1.0 | 0.0 | 2.74 | 2.61 | 0.5 | --- | 8-22-47 |

| CRD No. | Source | Organic Color, Fig. | Type | Strength Per Cent 3 Day | Strength Per Cent 7 Day | Compressive Strength, psi 3 Day | Compressive Strength, psi 7 Day | Flow % | Sand lb | Sieve Analysis Individual % Retained 4 | 8 | 16 | 30 | 50 | 100 | 200 | Pan | F.M. | Sp Gr | Abs % | $MgSO_4$ Loss % | Date Rec'd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOB-2 G-3(S) | White, Ga. | --- | Mfg. | 95 | 106 | 2525 | 4308 | 96 | 3.14 | 8.4 | 27.5 | 25.8 | 16.9 | 9.4 | 5.2 | 3.2 | 3.6 | 3.66 | 2.82 | 0.9 | 2.5 | 4-28-47 |
| MOB-2 S-1 | Cartersville, Ga. | --- | Nat. | -- | -- | -- | -- | | | 0.0 | 14.2 | 19.4 | 20.4 | 15.8 | 11.0 | 10.4 | 8.8 | 2.52 | 2.85 | 2.7 | 13.6 | 12-18-46 |
| NED-1 G-1(S)(A) | Willimantic, Conn. | 5 | Nat. | 62 | 89 | 1692 | 3544 | 100 | 3.74 | 0.6 | 11.3 | 17.6 | 27.7 | 22.9 | 10.8 | 5.3 | 3.8 | 2.70 | 2.73 | 1.5 | 4.4 | 3-15-19-47 |
| NED-1 G-1(S)(B) | Willimantic, Conn. | 3 | Nat. | 66 | 93 | 1800 | 3744 | 98 | 3.54 | 0.5 | 14.8 | 19.8 | 27.9 | 21.8 | 10.9 | 3.7 | 0.6 | 2.90 | 2.74 | 1.0 | 5.0 | 3-15-19-47 |
| NED-1 G-1(S)(C) | Willimantic, Conn. | 1 | Nat. | 109 | 105 | 2742 | 4500 | 100 | 3.50 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 3-15-19-47 |
| NED-1 G-2(S)(A) | Willimantic, Conn. | 3 | Nat. | 81 | 92 | 2217 | 3698 | | 3.50 | 0.7 | 11.4 | 15.7 | 25.4 | 26.7 | 13.9 | 4.0 | 2.2 | 2.68 | 2.72 | 1.5 | 4.5 | 3-15-19-47 |
| NED-1 G-2(S)(B) | Willimantic, Conn. | 3 | Nat. | 88 | 99 | 2408 | 3950 | | 3.39 | 0.3 | 12.6 | 16.8 | 26.4 | 26.6 | 13.6 | 3.2 | 0.5 | 2.78 | 2.73 | 1.0 | 5.0 | 3-15-19-47 |
| NED-2 S-1 | Union Village, Vt. | 5 | Nat. | 77 | 82 | 2225 | 3867 | | 3.16 | 0.0 | 6.6 | 16.0 | 24.9 | 32.6 | 14.3 | 4.5 | 1.1 | 2.51 | 2.66 | 1.6 | 3.0 | 4- 3-47 |
| NED-2 S-2 | West Lebanon, N. H. | 0 | Nat. | 95 | 96 | 2181 | 3275 | 95 | 3.07 | 1.5 | 8.4 | 12.3 | 30.2 | 37.5 | 7.2 | 1.9 | 1.0 | 2.73 | 2.67 | 1.1 | 3.2 | 9-15-47 |
| NED-3 S-1 | Northfield, Mass. | 1 | Nat. | 89 | 95 | 2442 | 3542 | 95 | 2.00 | 1.0 | 14.1 | 23.1 | 25.1 | 20.5 | 11.6 | 2.6 | 1.9 | 2.97 | 2.69 | 1.2 | 2.7 | 4-28-47 |
| NED-3 S-2 | Barre, Mass. | 2 | Nat. | 90 | 107 | 2008 | 3592 | | 2.30 | 0.0 | 6.2 | 10.5 | 20.3 | 43.0 | 17.1 | 2.5 | 0.4 | 2.37 | 2.64 | 0.9 | 5.0 | 6-16-47 |
| NED-4 S-1 | Wilbraham, Mass. | 2 | Nat. | 118 | 95 | 2900 | 4100 | 95 | 2.53 | 1.8 | 10.9 | 13.8 | 25.8 | 28.0 | 12.2 | 5.1 | 2.4 | 2.66 | 2.66 | 1.2 | 5.6 | 5-14-47 |
| NED-4 S-2 | Westfield, Mass. | 2 | Nat. | 109 | 92 | 2662 | 3975 | 97 | 1.87 | 3.8 | 17.7 | 18.4 | 27.8 | 23.6 | 6.6 | 1.8 | 0.3 | 3.22 | 2.74 | 1.4 | 5.4 | 5-14-47 |
| NED-5 G-1(S) | Limestone, Maine | --- | Mfg. | 90 | 69 | 2192 | 3213 | 92 | 1.79 | 0.1 | 23.9 | 20.9 | 15.6 | 10.6 | 5.9 | 5.6 | 17.4 | 2.78 | 2.64 | 2.0 | 6.9 | 6- 4-47 |
| NED-5 G-2A(S) | Limestone, Maine | 1 | Nat. | 95 | 79 | 2367 | 3242 | 98 | 2.10 | 5.7 | 38.4 | 21.0 | 13.9 | 8.5 | 2.9 | 2.1 | 7.5 | 3.72 | 2.63 | 1.8 | 4.9 | 6- 4-47 |
| NED-5 G-2B(S) | Limestone, Maine | 2 | Nat. | 103 | 95 | 2563 | 3863 | 95 | 2.52 | 0.3 | 23.7 | 19.8 | 19.9 | 17.1 | 6.4 | 3.8 | 9.0 | 3.00 | 2.58 | 2.9 | 7.4 | 6- 4-47 |
| NED-5 G-2C(S) | Limestone, Maine | 2 | Nat. | 105 | 101 | 2600 | 4108 | 92 | 2.26 | 0.2 | 14.5 | 17.5 | 21.4 | 16.7 | 10.0 | 9.7 | 10.0 | 2.51 | 2.58 | 2.3 | 6.8 | 6- 4-47 |
| NED-5 G-2D(S) | Limestone, Maine | 2 | Nat. | 104 | 97 | 2872 | 4142 | 93 | 2.29 | 1.2 | 14.1 | 11.0 | 15.3 | 26.3 | 16.6 | 7.4 | 8.1 | 2.37 | 2.54 | 3.5 | 7.1 | 6- 4-47 |
| NED-5 G-2E(S) | Limestone, Maine | 2 | Nat. | 110 | 95 | 3025 | 4048 | 90 | 2.34 | 1.9 | 19.8 | 14.5 | 15.0 | 18.5 | 7.2 | 4.8 | 18.3 | 2.58 | 2.53 | 2.6 | 11.1 | 6- 4-47 |
| NED-5 G-2(S) | Limestone, Maine | 2 | Nat. | 89 | 86 | 2213 | 3513 | 99 | 1.70 | 0.2 | 20.3 | 17.6 | 17.8 | 17.5 | 9.6 | 6.2 | 10.8 | 2.81 | 2.60 | 2.9 | 8.8 | 6- 4-47 |
| NED-5 G-3(S) | Limestone, Maine | --- | Mfg. | 102 | 97 | 2633 | 3842 | 98 | 2.62 | 1.0 | 8.7 | 11.2 | 29.5 | 29.0 | 13.8 | 5.0 | 1.8 | 2.55 | 2.63 | 0.8 | 9.1 | 7-14-47 |
| NED-5 S-1 (Processed) | Limestone, Maine | 1 | Nat. | 74 | 65 | 1796 | 2992 | 96 | 2.03 | 0.1 | 11.6 | 13.9 | 12.7 | 22.2 | 21.6 | 12.4 | 5.5 | 2.18 | 2.59 | 2.6 | 8.9 | 6- 4-47 |
| NED-5 S-1 (Unprocessed) | Limestone, Maine | 4 | Nat. | 74 | 65 | 1796 | 2992 | 96 | 2.03 | 0.1 | 11.6 | 13.9 | 12.7 | 22.2 | 21.6 | 12.4 | 5.5 | 2.18 | 2.60 | 2.3 | 7.0 | 6- 4-47 |
| NED-6 S-2(2) | Keene, N. H. | 2 | Nat. | 88 | 87 | 2542 | 3900 | 104 | 2.83 | 0.0 | 5.5 | 20.2 | 35.0 | 30.0 | 7.3 | 1.7 | 0.3 | 2.81 | 2.67 | 0.5 | 3.3 | 10-20-47 |
| NED-6 S-3(2) | Manchester, N. H. | 2 | Nat. | 82 | 82 | 2433 | 3642 | 100 | 2.95 | 1.4 | 8.9 | 19.9 | 36.9 | 26.2 | 5.5 | 1.0 | 0.2 | 3.01 | 2.66 | 0.5 | 2.4 | 10-24-47 |
| NED-7 S-1 | Holden, Mass. | 0 | Nat. | 107 | 130 | 2323 | 3790 | 95 | 3.36 | 3.6 | 11.2 | 17.6 | 27.7 | 24.4 | 13.3 | 4.3 | 0.9 | 2.84 | 2.62 | 0.9 | 2.5 | 11- 6-47 |
| NOR-1 S-1 | Buggs Island, Va. | 0 | Mfg. | 102 | 90 | 2500 | 3617 | 98 | 2.16 | 0.3 | 8.8 | 17.1 | 16.6 | 19.5 | 16.0 | 11.8 | 9.9 | 2.19 | 2.62 | 0.5 | 4.1 | 5-23-47 |
| OM-1 S-16 | Grano-Greene, N. D. | 2+ | Nat. | 86 | 74 | 2479 | 3333 | 101 | 2.70 | 0.0 | 8.9 | 11.0 | 33.5 | 27.7 | 13.3 | 1.4 | 4.2 | 2.58 | 2.62 | 1.4 | 4.2 | 3- 1-47 |
| OM-2 G-7(S) | Dell Rapids, S. D. | --- | Mfg. | 72 | 90 | 1750 | 4284 | 95 | 2.17 | 0.6 | 11.4 | 19.7 | 19.3 | 22.0 | 15.6 | 8.0 | 3.4 | 2.47 | 2.63 | 0.5 | 3.9 | 3-11-47 |
| OM-2 G-9(2)(S) | Rapid City, S. D. | --- | Mfg. | 94 | 105 | 2083 | 3525 | 95 | 2.35 | 0.1 | 8.3 | 27.5 | 28.8 | 17.0 | 7.3 | 2.1 | 8.9 | 2.80 | 2.66 | 0.9 | 3.1 | 3-11-47 |
| OM-2 G-11 (S) | La Platte, Nebr. | --- | Mfg. | 104 | 114 | 2675 | 4188 | 93 | 2.89 | 0.4 | 30.6 | 23.7 | 17.6 | 17.2 | 8.4 | 1.8 | 0.3 | 3.46 | 2.60 | 0.3 | 4.0 | 5- 6-47 |
| OM-2 S-12 | Lake Andes, S. D. | 1 | Nat. | 93 | 103 | 2400 | 3683 | 102 | 2.12 | 2.6 | 8.9 | 10.3 | 34.0 | 28.6 | 8.2 | 6.0 | 1.4 | 2.69 | 2.57 | 2.6 | 12.7 | 8- 5-47 |
| OM-3 S-4 | Oahe, S. D. | 4 | Nat. | 92 | 94 | 2383 | 3725 | 100 | 2.02 | 2.9 | 7.3 | 9.0 | 35.2 | 30.4 | 9.6 | 3.5 | 2.1 | 2.66 | 2.63 | 1.4 | 5.7 | 7-16-47 |
| OM-3 S-5 | Watertown, S. D. | 2 | Nat. | 99 | 90 | 2567 | 3542 | 102 | 3.22 | 2.6 | 11.8 | 29.1 | 38.4 | 16.1 | 1.6 | 0.3 | 0.1 | 3.40 | 2.64 | 1.2 | 7.0 | 7-16-47 |
| SAC-1 S-3 | Mill Creek, Calif. | 3 | Nat. | 92 | 95 | 2825 | 3975 | 93 | 2.58 | 1.0 | 4.4 | 10.2 | 26.1 | 25.7 | 17.7 | 9.4 | 5.5 | 2.16 | 2.69 | 1.2 | 6.9 | 4- 1-47 |
| SAC-1 G-5-8(S) | Mill Creek, Calif. | --- | Mfg. | 113 | 118 | 2833 | 4217 | 102 | 3.09 | 2.4 | 9.2 | 14.9 | 22.8 | 26.9 | 15.0 | 8.8 | 0.0 | 2.57 | 2.86 | 1.0 | 6.4 | 4- 1-47 |
| SAC-3 S-1 | Isabella, Calif. | 3 | Nat. | 93 | 92 | 2033 | 2600 | 102 | 2.80 | 1.3 | 6.2 | 27.4 | 30.3 | 19.3 | 10.9 | 4.6 | 0.0 | 2.89 | 2.62 | 1.7 | 5.5 | 10-13-47 |
| SAC-4 G-1(S) | Red Bluff, Calif. | --- | Mfg. | 107 | 112 | 1938 | 2648 | 100 | 3.56 | 9.0 | 9.8 | 11.2 | 21.3 | 32.3 | 10.4 | 2.2 | 3.8 | 2.83 | 2.67 | 1.9 | 2.5 | 11-20-47 |
| SAV-1 G-1(S) | Clark Hill, S. C. | --- | Mfg. | 105 | 118 | 2696 | 4333 | 100 | 1.97 | 0.2 | 6.7 | 14.8 | 29.0 | 30.5 | 12.3 | 4.9 | 1.6 | 2.54 | 2.63 | 0.6 | 2.1 | 5- 7-47 |
| SAV-1 G-2(S) | Clark Hill, Ga. | --- | Mfg. | 101 | 112 | 2608 | 4104 | 100 | 1.80 | 0.0 | 8.1 | 15.6 | 32.0 | 27.2 | 10.8 | 4.3 | 2.0 | 2.64 | 2.59 | 1.2 | 3.4 | 5- 7-47 |
| STL-2 G-2(S) | Krause, Ill. | --- | Mfg. | 115 | 121 | 2094 | 3172 | 100 | 3.11 | 0.0 | 5.5 | 18.3 | 32.4 | 23.3 | 15.5 | 4.1 | 0.9 | 2.60 | 2.63 | 1.8 | 5.0 | 9-26-47 |
| STL-2 G-3(S) | Prairie Durocher, Ill. | --- | Mfg. | 130 | 141 | 2371 | 3708 | 100 | 3.04 | 0.0 | 18.7 | 23.7 | 14.6 | 21.0 | 10.2 | 2.5 | 9.3 | 2.84 | 2.63 | 1.7 | 5.2 | 11- 8-47 |
| STL-2 S-1 | Mississippi River, St. Louis, Mo. | 4 | Nat. | 100 | 100 | (2798 | 3758) | 102 | 2.95 | 3.7 | 9.6 | 18.3 | 37.3 | 25.8 | 2.9 | 2.3 | 0.1 | 3.10 | 2.62 | 0.4 | 4.7 | 9-26-47 |
| STL-2 S-2 | Mitchell, Ill. | 3 | Nat. | 100 | 100 | (90%STL<br>(10%STL | 2S-1)<br>2S-2) | 102 | 2.95 | 0.0 | 0.0 | 0.0 | 0.7 | 3.9 | 50.3 | 40.3 | 4.8 | 0.60 | 2.58 | 1.3 | --- | 9-26-47 |
| TUL-1 G-9(S) | Tulsa, Okla. | --- | Mfg. | 125 | 124 | 2850 | 5033 | 98 | 2.54 | 0.1 | 7.1 | 15.4 | 32.7 | 28.1 | 9.9 | 4.1 | 2.6 | 2.62 | 2.64 | 1.5 | 4.2 | 12-26-46 |
| TUL-1 G-16(S) | Fort Gibson, Okla. | --- | Mfg. | 118 | 115 | 2700 | 4650 | 100 | 3.07 | 0.6 | 8.4 | 13.5 | 29.8 | 30.2 | 9.4 | 2.7 | 5.4 | 2.59 | 2.64 | 1.3 | 6.0 | 2-27-47 |
| TUL-1 G-17(S) | Fort Gibson, Okla. | --- | Mfg. | 116 | 129 | 3067 | 5592 | 100 | 3.15 | 0.1 | 10.6 | 23.4 | 24.3 | 18.3 | 12.4 | 6.1 | 4.8 | 2.69 | 2.67 | 1.1 | 3.7 | 3- 8-47 |
| TUL-1 G-21(S) | Richard Spur, Okla. | --- | Mfg. | 110 | 114 | 2908 | 4925 | 97 | 2.94 | 0.0 | 8.2 | 15.7 | 32.0 | 24.2 | 13.4 | 3.4 | 3.1 | 2.62 | 2.65 | 1.2 | 3.4 | 3- 8-47 |
| TUL-1 G-24(S) | Little Rock, Ark. | --- | Mfg. | 139 | 135 | 2723 | 5140 | 100 | 3.35 | 2.1 | 22.6 | 20.2 | 19.5 | 13.9 | 10.4 | 9.3 | 2.0 | 2.93 | 2.60 | 0.3 | 1.5 | 3-25-47 |
| TUL-1 S-1(2) | Van Buren, Ark. | 2 | Nat. | 114 | 99 | 2134 | 3700 | 100 | 4.28 | 4.3 | 9.2 | 16.5 | 22.7 | 26.9 | 16.3 | 3.4 | 0.7 | 2.76 | 2.60 | 0.5 | 3.5 | 12- 9-46 |
| TUL-1 S-1(3) | Van Buren, Ark. | 1 | Nat. | 93 | 129 | 2475 | 5592 | 102 | 4.02 | 5.2 | 6.7 | 13.7 | 24.3 | 32.4 | 12.8 | 4.3 | 0.6 | 2.70 | 2.61 | 0.6 | 2.5 | 2-25-47 |
| TUL-2 S-2 | Fall River, Kans. | 1 | Nat. | 112 | 91 | 2158 | 3242 | 100 | 4.07 | 1.4 | 8.6 | 15.0 | 35.0 | 28.0 | 10.0 | 0.8 | 1.2 | 2.92 | 2.61 | 1.2 | 16.2 | 12-21-46 |
| TUL-3 S-1 | Ralston, Okla. | 2 | Nat. | 108 | 96 | 2675 | 3918 | 100 | 1.88 | 0.0 | 0.0 | 0.0 | 0.0 | 8.8 | 36.9 | 41.2 | 13.1 | 0.55 | 2.61 | 0.5 | 0.4 | 5-27-47 |
| TUL-3 S-2 | Arkansas River, Ark. | 0 | Nat. | 105 | 96 | 2604 | 3908 | 100 | 2.78 | 1.8 | 5.3 | 12.2 | 20.7 | 42.7 | 16.0 | 1.1 | 0.2 | 2.50 | 2.62 | 0.2 | 1.8 | 5-26-47 |
| VICKS-1 S-2 | Murfreesboro, Ark. | 3 | Nat. | 91 | 91 | 2539 | 3408 | 104 | 3.73 | 2.2 | 15.0 | 13.3 | 17.8 | 31.4 | 12.8 | 4.6 | 2.9 | 2.70 | 2.55 | 1.7 | 4.4 | 9-25-47 |
| BA-1 S-1(2) | Vestal, N. Y. | 1 | Nat. | 117 | 88 | 1957 | 2541 | 98 | 4.12 | 2.7 | 12.6 | 8.3 | 15.6 | 42.7 | 12.6 | 2.6 | 2.9 | 2.57 | 2.62 | 1.6 | 14.5 | 12-22-47 |
| BA-2 S-1 | Bloomsburg, Pa. | 2 | Nat. | 107 | 116 | 2983 | 4542 | 102 | 4.05 | 1.0 | 7.5 | 9.4 | 22.1 | 39.0 | 16.8 | 3.2 | 1.0 | 2.42 | 2.62 | 1.4 | 10.3 | 9-16-48 |
| BUF-4 G-31 B & C(S) | Leroy, N. Y. | --- | Mfg. | 96 | 98 | 2858 | 2975 | 95 | 3.19 | 0.0 | 5.4 | 16.6 | 33.2 | 28.6 | 10.8 | 2.6 | 2.8 | 2.61 | 2.59 | 3.5 | 34.1 | 3-31-48 |
| BUF-4 G-31 Upper Zone B & C(S) | Leroy, N. Y. | --- | Mfg. | 109 | 95 | 3258 | 3858 | 100 | 3.07 | 0.0 | 6.2 | 16.7 | 31.9 | 26.2 | 14.2 | 3.5 | 1.3 | 2.60 | 2.67 | 0.8 | 8.4 | 3-31-48 |
| BUF-4 G-32(S) | Leroy, N. Y. | --- | Mfg. | 112 | 113 | 3817 | 4733 | 104 | 2.61 | 0.0 | 4.3 | 24.6 | 29.2 | 24.4 | 11.6 | 4.8 | 1.1 | 2.68 | 2.63 | 1.0 | 7.3 | 5- 2-48 |
| BUF-4 G-33(A)(S) | Leroy, N. Y. | --- | Mfg. | 136 | 151 | 3350 | 4975 | 102 | 2.71 | 0.5 | 4.8 | 16.0 | 26.8 | 31.9 | 14.0 | 4.6 | 1.4 | 2.49 | 2.66 | 0.7 | 14.2 | 5- 2-48 |

(Continued on next page)

Table 1 (Continued)



| CRD No. | Source | Organic Color, Fig. | Type | Strength Per Cent 3 Day | Strength Per Cent 7 Day | Compressive Strength, psi 3 Day | Compressive Strength, psi 7 Day | Flow % | Sand lb | Sieve Analysis Individual % Retained 4 | 8 | 16 | 30 | 50 | 100 | 200 | Pan | F.M. | Sp Gr | Abs. % | $MgSO_4$ Loss % | Date Rec'd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BUF-4 G-33(B)(S) | Leroy, N. Y. | --- | Mfg. | 150 | 151 | 3692 | 4968 | 100 | 2.71 | 0.3 | 4.5 | 15.3 | 28.2 | 31.6 | 14.0 | 4.5 | 1.6 | 2.47 | 2.66 | 0.7 | 9.1 | 5- 2-48 |
| BUF-4 G-32(S) | Leroy, N. Y. | --- | Mfg. | 167 | 147 | 4108 | 4850 | 102 | 2.71 | 0.0 | 5.2 | 16.8 | 30.9 | 29.5 | 12.9 | 3.7 | 1.0 | 2.58 | 2.64 | 1.0 | 7.0 | 5- 2-48 |
| CRD S-4(3) | Georgetown, Miss. | 1 | Nat. | 101 | 104 | 2600 | 3944 | 100 | 3.54 | 2.4 | 8.1 | 13.5 | 23.8 | 40.9 | 9.9 | 1.1 | 0.3 | 2.72 | 2.63 | 0.5 | 2.9 | 4-30-48 |
| CRD S-4(4) | Georgetown, Miss. | 1 | Nat. | 101 | 104 | 2600 | 3944 | 100 | 3.54 | 2.5 | 9.7 | 12.8 | 30.1 | 30.7 | 11.2 | 1.8 | 1.2 | 2.78 | 2.63 | 0.5 | 2.9 | 4-30-48 |
| GAR-1 G-6(S) | Ortonville, Minn. | --- | Mfg. | 122 | 103 | 3050 | 3917 | 94 | 3.50 | 0.0 | 1.5 | 21.0 | 37.4 | 25.7 | 11.5 | 2.6 | 0.3 | 2.67 | 2.61 | 0.4 | 5.5 | 8-27-48 |
| GAR-1 G-7(S) | Warman, Minn. | --- | Mfg. | 135 | 114 | 3383 | 4350 | 104 | 3.50 | 0.7 | 10.6 | 16.2 | 31.0 | 24.5 | 13.2 | 3.4 | 0.4 | 2.77 | 2.65 | 0.7 | 3.8 | 9- 1-48 |
| GAR-1 S-1 | Minot, N. D. | 5+ | Nat. | 113 | 82 | 1878 | 2384 | 98 | 4.42 | 3.3 | 17.1 | 22.3 | 31.3 | 20.1 | 4.0 | 0.4 | 1.5 | 3.33 | 2.60 | 1.9 | 6.1 | 12-15-48 |
| GAR-1 S-2 | St. Cloud, Minn. | 2 | Nat. | 99 | 112 | 2041 | 3448 | 95 | 4.05 | 1.0 | 4.6 | 20.4 | 28.0 | 29.6 | 10.1 | 2.7 | 3.6 | 2.64 | 2.60 | 1.2 | 3.5 | 12-15-47 |
| GAR-1 S-3(2) | Garrison, N. D. | 4 | Nat. | 106 | 109 | 2708 | 3825 | 95 | 4.73 | 0.0 | 4.0 | 22.1 | 30.6 | 30.5 | 11.3 | 0.8 | 0.7 | 2.73 | 2.63 | 1.1 | 3.0 | 9- 7-48 |
| GAR-1 S-4 | Garrison, N. D. | 5+ | Nat. | 97 | 103 | 3008 | 4308 | 104 | 4.85 | 0.3 | 24.2 | 22.3 | 21.8 | 23.5 | 5.9 | 0.9 | 1.1 | 3.30 | 2.61 | 1.1 | 2.8 | 8-16-48 |
| GAR-1 S-5 | Detroit Lakes, Minn. | 2 | Nat. | 120 | 120 | 3417 | 4533 | 100 | 4.50 | 0.0 | 18.5 | 24.4 | 25.2 | 20.0 | 8.6 | 1.6 | 1.7 | 3.14 | 2.64 | 1.3 | 9.8 | 10- 1-48 |
| GAR-1 S-5(3) | Detroit Lakes, Minn. | 3 | Nat. | 96 | 105 | 2833 | 4208 | 98 | 4.27 | 0.0 | 10.5 | 18.6 | 28.3 | 28.4 | 10.7 | 2.7 | 0.8 | 2.69 | 2.60 | 1.4 | 7.5 | 10-28-48 |
| GAR-1 S-7 | Detroit Lakes, Minn. | 2 | Nat. | 112 | 114 | 3667 | 5042 | 102 | 3.70 | 0.0 | 6.5 | 12.9 | 18.4 | 33.7 | 24.4 | 1.9 | 2.2 | 2.31 | 2.62 | 1.3 | 5.9 | 10- 1-48 |
| GAR-1 S-7(2) | Detroit Lakes, Minn. | 3 | Nat. | --- | --- | --- | --- | --- | --- | 0.0 | 0.4 | 0.7 | 1.0 | 12.7 | 67.0 | 16.5 | 1.7 | 1.00 | 2.62 | 0.7 | 1.2 | 10-28-48 |
| KAN-4 G-1(3)(S) | Lincoln, Kans. | --- | Mfg. | 122 | 113 | 2310 | 3500 | 120 | 3.65 | 0.0 | 3.7 | 17.1 | 25.7 | 30.4 | 18.1 | 3.8 | 1.2 | 2.46 | 2.62 | 1.3 | 32.3 | 1- 2-48 |
| KAN-4 G-2(3)(S) | Amazonia, Mo. | --- | Mfg. | 112 | 115 | 4300 | 6033 | 95 | 3.70 | 0.0 | 6.0 | 18.3 | 30.4 | 25.2 | 14.5 | 3.6 | 2.0 | 2.59 | 2.60 | 2.4 | --- | 3-13-48 |
| KAN-4 G-7(S) | Guernsey, Wyo. | --- | Mfg. | 118 | 109 | 3575 | 4142 | 104 | 3.09 | 0.0 | 5.5 | 15.7 | 29.0 | 29.4 | 12.7 | 5.9 | 1.8 | 2.49 | 2.82 | 0.4 | 6.5 | 5-17-48 |
| KAN-5 S-1 | Golden, Colo. | 1 | Nat. | 121 | 126 | 3492 | 4750 | 100 | 3.30 | 2.5 | 11.8 | 15.6 | 23.7 | 28.1 | 11.8 | 4.6 | 1.9 | 2.76 | 2.63 | 0.9 | 9.1 | 6-29-48 |
| LR-1 G-69(S) | Flippin, Ark. | --- | Mfg. | 131 | 125 | 3358 | 4483 | 97 | 3.13 | 0.0 | 8.6 | 19.7 | 24.2 | 22.3 | 15.9 | 7.4 | 1.9 | 2.55 | 2.75 | 0.7 | 14.5 | 3-10-48 |
| MOB-2 G-3(S)(2) | Cartersville, Ga. | --- | Mfg. | 150 | 138 | 2948 | 4026 | 100 | 3.81 | 0.0 | 13.8 | 27.6 | 25.5 | 14.4 | 8.1 | 4.8 | 5.8 | 2.93 | 2.83 | 0.7 | 3.5 | 11-13-47 |
| MOB-2 G-3(4)(S) | Cartersville, Ga. | --- | Mfg. | 139 | 120 | 2741 | 3486 | 100 | 3.57 | 7.7 | 26.4 | 22.9 | 14.8 | 8.5 | 5.7 | 4.4 | 9.6 | 3.37 | 2.80 | 1.7 | 3.6 | 12-10-47 |
| MOB-5 S-4(2) | Bogalusa, La. | 2 | Nat. | 111 | 114 | 3217 | 4450 | 98 | 3.70 | 2.2 | 11.2 | 9.0 | 20.5 | 46.2 | 9.9 | 0.8 | 0.2 | 2.69 | 2.61 | 0.4 | 2.6 | 9-21-48 |
| NO-1 S-3 | Amite, La. | 1 | Nat. | 107 | 113 | 3633 | 4733 | 102 | 3.85 | 9.7 | 12.2 | 12.1 | 13.7 | 36.5 | 13.8 | 1.5 | 0.5 | 2.96 | 2.60 | 0.5 | 4.7 | 6- 7-48 |
| NO-2 S-2 | Gillam Chute, La. | 5+ | Nat. | 96 | 108 | 3275 | 4508 | 100 | 3.71 | 3.1 | 11.1 | 17.8 | 26.1 | 37.7 | 3.9 | 0.2 | 0.1 | 3.03 | 2.61 | 0.6 | 2.3 | 5-27-48 |
| NO-3 S-1 | Turkey Creek, La. | 1- | Nat. | 96 | 90 | 2219 | 2956 | 98 | 4.18 | 0.6 | 3.8 | 10.0 | 25.4 | 52.7 | 5.3 | 0.9 | 1.3 | 2.50 | 2.61 | 1.1 | 4.0 | 1-26-48 |
| NO-4 S-4 | Baton Rouge, La. | 1 | Nat. | 98 | 101 | 2530 | 3842 | 95 | 3.57 | 5.8 | 12.1 | 9.9 | 10.0 | 42.1 | 18.1 | 1.5 | 0.5 | 2.67 | 2.61 | 0.7 | 2.9 | 4-22-48 |
| NO-5 S-1 | Webster Parish, La. | 1 | Nat. | 110 | 123 | 3233 | 3733 | 100 | 4.80 | 3.8 | 13.1 | 9.3 | 12.3 | 43.0 | 16.1 | 2.2 | 0.2 | 2.59 | 2.62 | 0.4 | 3.5 | 6-23-48 |
| NO-7 S-1 | Indian Village, La. | 1 | Nat. | 87 | 94 | 3155 | 4342 | 98 | 4.30 | 3.5 | 8.2 | 9.0 | 12.7 | 55.7 | 9.3 | 1.4 | 0.2 | 2.57 | 2.64 | 0.5 | 2.7 | 10-21-48 |
| NOR-1 G-S(2)(S) | Buggs Island, Va. | --- | Mfg. | 110 | 118 | 3167 | 4458 | 100 | 3.30 | 0.0 | 4.8 | 18.3 | 25.1 | 26.1 | 15.1 | 7.6 | 3.0 | 2.63 | 2.61 | 0.5 | 12.1 | 5-19-48 |
| NOR-1 G-5(3)(S) | Buggs Island, Va. | --- | Mfg. | 130 | 123 | 3250 | 4667 | 112 | 3.50 | 0.0 | 4.9 | 16.4 | 30.4 | 26.6 | 14.5 | 5.1 | 2.1 | 2.49 | 2.62 | 0.6 | 13.3 | 9- 2-48 |
| NOR-2 G-1(S)(2) | Blue Ridge, Va. | --- | Mfg. | 121 | 118 | 2933 | 3742 | 93 | 3.61 | 0.0 | 7.4 | 19.3 | 29.4 | 20.7 | 16.7 | 5.9 | 0.6 | 2.61 | 2.75 | 0.9 | 6.4 | 12-29-47 |
| NOR-2 G-1(S)(3) | Blue Ridge, Va. | --- | Mfg. | 120 | 123 | 2900 | 3883 | 100 | 3.34 | 0.0 | 7.8 | 19.7 | 28.2 | 21.2 | 15.0 | 6.6 | 1.5 | 3.60 | 2.77 | 0.7 | 6.9 | 12-29-47 |
| NOR-2 G-2(S)(2) | Shelton, N. C. | --- | Mfg. | 117 | 120 | 2667 | 3396 | 95 | 3.22 | 0.0 | 0.4 | 2.3 | 12.3 | 32.6 | 33.7 | 16.9 | 1.8 | 1.47 | 2.60 | 0.7 | 6.9 | 1-28-48 |
| NOR-2 G-3(S)(3) | Roanoke, Va. | --- | Mfg. | 135 | 130 | 4167 | 4175 | 100 | 4.35 | 0.0 | 5.4 | 29.2 | 30.9 | 20.6 | 9.2 | 4.1 | 0.6 | 2.87 | 2.81 | 0.7 | 7.0 | 3- 2-48 |
| NOR-2 G-4(S)(3) | Buchanan, Va. | --- | Mfg. | 113 | 113 | 3298 | 4683 | 95 | 3.39 | 0.0 | 4.7 | 17.6 | 28.2 | 21.5 | 17.0 | 8.8 | 2.2 | 2.38 | 2.83 | 0.2 | 5.8 | 3- 9-48 |
| NOR-2 G-5(S) | Radford, Va. | --- | Mfg. | 134 | 141 | 3933 | 5217 | 104 | 3.90 | 0.0 | 0.0 | 33.5 | 26.0 | 15.3 | 11.5 | 8.4 | 5.3 | 2.54 | 2.76 | 0.8 | 2.6 | 10-11-48 |
| NOR-2 G-6(S) | Pembroke, Va. | --- | Mfg. | 107 | 114 | 3950 | 5250 | 104 | 3.56 | 0.0 | 0.0 | 27.2 | 31.7 | 19.8 | 10.9 | 4.1 | 6.3 | 2.54 | 2.78 | 0.8 | 5.2 | 10-11-48 |
| NOR-2 G-7(S) | Ripplemead, Va. | --- | Mfg. | 110 | 113 | 4056 | 5217 | 90 | 4.16 | 0.0 | 0.3 | 36.4 | 27.8 | 13.2 | 7.1 | 4.8 | 10.4 | 2.64 | 2.79 | 0.7 | 6.0 | 10-11-48 |
| NOR-2 S-1 | Chester, Va. | --- | Mfg. | 95 | 92 | 3506 | 4225 | 98 | 3.80 | 0.8 | 5.1 | 15.7 | 39.4 | 30.8 | 6.5 | 1.1 | 0.6 | 2.79 | 2.60 | 0.9 | 8.5 | 10-11-48 |
| NOR-2 S-1(A) | Chester, Va. | --- | Mfg. | --- | --- | --- | --- | --- | --- | 0.0 | 1.5 | 3.8 | 10.0 | 26.2 | 28.0 | 22.8 | 7.7 | 1.33 | 2.57 | 2.0 | 3.8 | 10-11-48 |
| OCE-4 S-2(2) | Columbus, Ga. | --- | Mfg. | 98 | 114 | 2884 | 3458 | 95 | 3.97 | 0.0 | 1.0 | 11.1 | 27.8 | 34.0 | 20.4 | 4.7 | 1.0 | 2.21 | 2.64 | 0.7 | 4.9 | 6-21-48 |
| OM-1 S-14(3) | Detroit Lakes, Minn. | 1 | Nat. | 109 | 112 | 3208 | 4458 | 102 | 4.50 | 0.2 | 13.6 | 30.2 | 33.6 | 17.7 | 3.9 | 0.5 | 0.3 | 3.30 | 2.64 | 0.9 | 8.5 | 10-28-48 |
| OM-2 G-5(4)(S) | Sioux Falls, S. D. | --- | Mfg. | 125 | 130 | 3208 | 4658 | 95 | 2.71 | 1.6 | 7.8 | 30.5 | 14.9 | 16.1 | 14.1 | 8.6 | 6.1 | 2.61 | 2.62 | 0.4 | 4.2 | 5-13-48 |
| OM-2 G-5(9)(S) | Sioux Falls, S. D. | --- | Mfg. | 136 | 122 | 3408 | 4650 | 104 | 3.50 | 0.0 | 8.1 | 13.5 | 29.5 | 30.1 | 13.9 | 3.7 | 1.2 | 2.57 | 2.61 | 0.6 | 2.8 | 8-30-48 |
| OM-2 G-11(3) | | | | | | | | | | | | | | | | | | | | | | |
| OM-2 G-11(3)(S) | La Platte, Nebr. | --- | Mfg. | 115 | 117 | 2625 | 3317 | 97 | 4.33 | 0.0 | 6.8 | 12.8 | 28.4 | 35.0 | 14.0 | 3.4 | 0.6 | 2.53 | 2.62 | 0.4 | 2.9 | 3- 1-48 |
| OM-2 S-4(9) | Hawarden, Iowa | 2 | Nat. | 121 | 117 | 3475 | 4384 | 100 | 4.55 | 1.3 | 14.2 | 21.4 | 20.3 | 34.2 | 7.2 | 1.1 | 0.3 | 3.01 | 2.62 | 1.0 | 4.9 | 6-30-48 |
| OM-2 S-4(9)(A) | Hawarden, Iowa | 2 | Nat. | 129 | 122 | 3708 | 4617 | 103 | 3.30 | 0.1 | 0.2 | 4.5 | 22.2 | 50.6 | 17.4 | 3.7 | 1.3 | 2.05 | 2.61 | 1.3 | 4.0 | 6-30-48 |
| OM-2 S-10(4)(A) | Lake Andes, S. D. | 1 | Nat. | 116 | 102 | 3192 | 4242 | 103 | 5.00 | 3.0 | 17.5 | 29.6 | 22.7 | 18.6 | 7.3 | 1.0 | 0.3 | 3.37 | 2.64 | 0.3 | 5.5 | 9-24-48 |
| OM-2 S-10(4)(B) | Lake Andes, S. D. | 1 | Nat. | 111 | 112 | 3250 | 4146 | 103 | 5.00 | 3.8 | 11.7 | 21.4 | 27.4 | 23.8 | 10.3 | 1.3 | 0.3 | 3.07 | 2.59 | 0.4 | 10.9 | 9-24-48 |
| OM-2 S-10(4)(C) | Lake Andes, S. D. | 1 | Nat. | 128 | 130 | 3758 | 4804 | 100 | 3.78 | 5.3 | 11.8 | 21.3 | 25.0 | 23.7 | 10.3 | 1.8 | 0.8 | 3.07 | 2.60 | 0.5 | 9.1 | 9-24-48 |
| OM-2 S-13(A) | Fort Randall, S. D. | 1 | Nat. | 96 | 101 | 3144 | 4475 | 96 | 4.50 | 2.7 | 33.1 | 34.7 | 18.9 | 6.2 | 2.5 | 1.0 | 0.9 | 3.92 | 2.74 | 1.6 | 13.4 | 9-24-48 |
| OM-2 S-13(B) | Fort Randall, S. D. | 2 | Nat. | 96 | 101 | 3144 | 4483 | 100 | 3.80 | 0.6 | 18.6 | 28.6 | 25.7 | 9.7 | 8.2 | 5.4 | 3.2 | 3.16 | 2.57 | 2.7 | 13.5 | 9-24-48 |
| OM-2 S-13(C) | Fort Randall, S. D. | 3 | Nat. | 98 | 102 | 2042 | 3867 | 90 | 2.22 | 1.4 | 14.6 | 23.5 | 23.1 | 16.2 | 6.6 | 3.7 | 10.9 | 2.84 | 2.54 | 3.8 | 12.4 | 9-24-48 |
| OM-3 G-7(2)(S) | Rapid Canyon, S. D. | --- | Mfg. | 114 | 111 | 3400 | 4492 | 103 | 2.86 | 0.0 | 6.3 | 17.1 | 28.4 | 26.6 | 15.3 | 4.9 | 1.4 | 2.54 | 2.66 | 0.7 | 7.2 | 5-30-47 |
| OM-3 G-10(S) | Rapid City, S. D. | --- | Mfg. | 107 | 108 | 2967 | 4233 | 107 | 108 | 1.4 | 9.3 | 14.8 | 31.3 | 24.3 | 14.1 | 3.6 | 1.2 | 2.71 | 2.64 | 0.5 | 5.5 | 9-15-48 |
| OM-3 S-6(3) | Wasta, S. D. | 2 | Nat. | 116 | 123 | 2613 | 3850 | 102 | 4.24 | 4.6 | 16.9 | 22.1 | 28.4 | 22.3 | 3.7 | 1.0 | 1.0 | 3.34 | 2.63 | 1.1 | 6.0 | 9- 1-48 |
| OM-6 G-1(2)(S) | Weeping Water, Nebr. | --- | Mfg. | 135 | 116 | 2558 | 3600 | 120 | 3.68 | 0.0 | 4.9 | 19.7 | 29.5 | 26.5 | 14.8 | 3.7 | 0.9 | 2.59 | 2.64 | 1.5 | 18.8 | 1- 2-48 |

(Continued on next page)

Table 1 (Continued)

| CRD No. | Source | Organic Color, Fig. | Type | Strength Per Cent 3 Day | Strength Per Cent 7 Day | Compressive Strength, psi 3 Day | Compressive Strength, psi 7 Day | Flow % | Sand lb | Sieve Analysis Individual % Retained 4 | 8 | 16 | 30 | 50 | 100 | 200 | Pan | F.M. | Sp Gr | Abs. % | MgSO4 Loss % | Date Rec'd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OM-8 G-1(B)(S) | Gilmore City, Iowa | --- | Mfg. | 127 | 125 | 2975 | 3772 | 104 | 3.91 | 0.0 | 5.6 | 15.1 | 28.2 | 30.2 | 15.4 | 4.1 | 1.4 | 2.49 | 2.64 | 1.3 | 17.5 | 3- 5-48 |
| OM-8 S-1 | Lake View, Iowa | 1+ | Nat. | 92 | 104 | 2365 | 3750 | 90 | 3.91 | 1.5 | 6.8 | 9.9 | 33.4 | 33.1 | 11.4 | 2.8 | 1.1 | 2.60 | 2.63 | 1.2 | 7.1 | 3-31-48 |
| PITT-1 S-1 | Pittsburgh, Pa. | 3 | Nat. | 117 | 121 | 3250 | 4742 | 95 | 4.55 | 2.5 | 16.5 | 16.1 | 17.2 | 28.6 | 13.9 | 3.3 | 1.9 | 2.85 | 2.59 | 1.5 | 8.7 | 8-17-48 |
| PITT-1 S-2 | Pittsburgh, Pa. | 3- | Nat. | 104 | 111 | 2883 | 4342 | 100 | 4.53 | 0.7 | 13.3 | 21.3 | 23.6 | 30.1 | 9.4 | 1.1 | 0.5 | 2.96 | 2.62 | 1.4 | 8.8 | 8-17-48 |
| PORT-1 G-3(S) | Whitman Creek, Ore. | --- | Nat. | 106 | 116 | 3067 | 4550 | 104 | 3.38 | 0.0 | 6.0 | 15.3 | 30.7 | 30.2 | 15.0 | 1.8 | 1.0 | 2.59 | 2.65 | 1.7 | 8.4 | 9-13-48 |
| PORT-2 S-1 | Row River, Ore. | 1 | Nat. | 99 | 96 | 2288 | 3167 | 98 | 3.87 | 2.2 | 20.5 | 32.5 | 21.7 | 13.3 | 5.8 | 2.9 | 1.1 | 3.43 | 2.58 | 4.3 | 10.4 | 2- 3-49 |
| PORT-2 S-1(2A) | Row River, Ore. | 2 | Nat. | 94 | 114 | 2908 | 4333 | 96 | 4.00 | 1.5 | 10.3 | 23.7 | 25.6 | 18.8 | 11.3 | 5.7 | 3.1 | 2.81 | 2.59 | 3.8 | 13.1 | 8-30-48 |
| PORT-3 S-1 | McNary, Ore.-Wash. | 2 | Nat. | 99 | 122 | 2392 | 3863 | 102 | 3.97 | 0.3 | 17.7 | 23.1 | 18.1 | 19.9 | 15.8 | 3.5 | 1.6 | 2.93 | 2.70 | 2.2 | 4.7 | 2-17-48 |
| SAC-1 G-10(S) | Pine Flat, Calif. | --- | Mfg. | 122 | 143 | 3576 | 4253 | 96 | 4.05 | 1.5 | 17.1 | 24.5 | 20.4 | 15.6 | 11.9 | 6.6 | 2.4 | 2.97 | 2.74 | 1.3 | 0.8 | 11- 9-47 |
| SAC-1 G-19(2)(S) | Kings River, Calif. | --- | Mfg. | 127 | 124 | 3750 | 4542 | 104 | 3.75 | 0.3 | 7.9 | 25.8 | 24.4 | 17.8 | 12.7 | 10.1 | 1.0 | 2.66 | 2.86 | 0.3 | 5.7 | 11-21-48 |
| SAC-1 G-19(2)(S)(A) | Kings River, Calif. | --- | Mfg. | 111 | 117 | 3267 | 4692 | 104 | 4.25 | 1.6 | 20.5 | 32.2 | 16.4 | 10.8 | 9.2 | 7.6 | 1.7 | 3.21 | 2.84 | 0.5 | 3.2 | 11-21-48 |
| SAC-1 G-20(4)(S) | Kings River, Calif. | --- | Mfg. | 127 | 114 | 3800 | 4658 | 100 | 3.90 | 1.1 | 8.5 | 15.2 | 30.3 | 27.8 | 13.0 | 3.3 | 0.8 | 2.70 | 2.82 | 0.5 | 5.8 | 11-16-48 |
| SAC-1 S-3 | Mill Creek, Calif. | --- | Nat. | 92 | 95 | 2825 | 3975 | --- | --- | 1.0 | 4.4 | 10.2 | 26.1 | 25.7 | 17.7 | 14.9 | 0.0 | 2.16 | 2.69 | 1.2 | 6.1 | 4- 1-47 |
| SAC-1 S-3 | Mill Creek, Calif. | --- | Nat. | 92 | 95 | 2825 | 3975 | --- | --- | 0.0 | 3.1 | 11.4 | 30.2 | 25.4 | 17.5 | 12.4 | 0.0 | 2.20 | 2.69 | 1.2 | 6.1 | 4- 1-47 |
| SAC-1 S-6 | Sanger, Calif. | 1 | Nat. | 116 | 117 | 3383 | 4333 | 98 | 3.40 | 0.0 | 12.8 | 15.7 | 26.4 | 33.2 | 8.9 | 2.4 | 0.6 | 2.81 | 2.61 | 1.2 | 15.4 | 10-18-48 |
| SAC-1 S-7 | Kings River, Calif. | 3 | Nat. | 112 | 105 | 3344 | 4283 | 104 | 2.88 | 0.2 | 5.4 | 8.8 | 15.6 | 26.9 | 27.9 | 10.9 | 4.3 | 1.92 | 2.64 | 1.2 | 8.1 | 11- 9-48 |
| SAC-1 S-8 | San Joaquin River, Calif. | 1 | Nat. | 95 | 102 | 2850 | 4183 | 92 | 3.90 | 3.5 | 11.1 | 18.6 | 29.7 | 21.2 | 11.2 | 3.5 | 1.2 | 2.94 | 2.64 | 1.1 | 14.0 | 11-11-49 |
| SAC-1 S-9(A) | Lower Mill Creek, Calif. | 1 | Nat. | 90 | 102 | 3200 | 3850 | 104 | 2.22 | 0.0 | 2.8 | 18.1 | 35.5 | 24.4 | 12.6 | 4.1 | 2.5 | 2.54 | 2.68 | 1.6 | 13.8 | 11-26-48 |
| SAC-1 S-9(B) | Lower Mill Creek, Calif. | 1 | Nat. | 84 | 102 | 2983 | 3825 | 102 | 3.74 | 0.0 | 4.7 | 25.2 | 38.4 | 18.8 | 8.0 | 3.3 | 1.6 | 2.85 | 2.67 | 1.1 | 14.1 | 11-26-48 |
| SAC-1 S-9(C) | Lower Mill Creek, Calif. | 1 | Nat. | 92 | 103 | 3383 | 3867 | 98 | 3.16 | 0.0 | 2.3 | 11.7 | 29.4 | 34.3 | 15.1 | 4.8 | 2.4 | 2.30 | 2.67 | 1.5 | 11.9 | 11-26-48 |
| SAC-1 S-9(D) | Lower Mill Creek, Calif. | 1 | Nat. | 97 | 109 | 3442 | 4100 | 90 | 3.44 | 0.0 | 2.2 | 14.3 | 34.2 | 31.1 | 11.8 | 4.3 | 2.1 | 2.45 | 2.67 | 1.4 | 13.4 | 11-26-48 |
| SAD-1 G-1(S) | North Wilkesboro, N. C. | --- | Mfg. | 126 | 110 | 2595 | 3379 | 98 | 2.77 | 0.0 | 2.3 | 14.3 | 23.2 | 23.3 | 8.1 | 27.4 | 1.4 | 1.93 | 2.61 | 0.6 | 5.4 | 11-11-47 |
| SAD-1 G-2(S) | North Wilkesboro, N. C. | --- | Mfg. | 102 | 96 | 2097 | 2954 | 96 | 2.37 | 0.0 | 3.3 | 12.7 | 21.0 | 36.0 | 17.8 | 8.2 | 1.0 | 2.20 | 2.65 | 0.9 | 1.7 | 11-11-47 |
| SAD-1 G-3(S) | Heggie Rock, Ga. | --- | Mfg. | 111 | 92 | 1848 | 2648 | 96 | 3.23 | 0.0 | 5.5 | 14.4 | 27.2 | 28.3 | 17.0 | 5.3 | 2.3 | 2.40 | 2.65 | 0.9 | 4.3 | 11-24-47 |
| SAD-1 S-4(A) | Augusta, Ga. | 1 | Nat. | 150 | 116 | 2490 | 3348 | 97 | 2.91 | 0.0 | 2.2 | 4.7 | 17.5 | 44.4 | 26.4 | 2.6 | 2.2 | 2.07 | 2.61 | 1.2 | 3.3 | 12-17-47 |
| SAD-1 S-4(B) | Augusta, Ga. | 2- | Nat. | 127 | 115 | 2628 | 3548 | 98 | 3.60 | 15.2 | 9.5 | 17.4 | 24.1 | 21.1 | 9.3 | 1.6 | 1.8 | 3.35 | 2.61 | 1.2 | 5.5 | 12-17-47 |
| STL-2 G-2(4)(S) | Krause, Ill. | --- | Mfg. | 122 | 124 | 3558 | 4850 | 100 | 3.12 | 0.0 | 8.2 | 14.2 | 29.0 | 27.4 | 13.1 | 3.8 | 4.3 | 2.53 | 2.60 | 2.9 | 19.3 | 9- 1-48 |
| STL-2 S-1(3) | St. Louis, Mo. | 4 | Nat. | 117 | 122 | 2992 | 4283 | 105 | 4.60 | 2.1 | 9.2 | 21.6 | 38.0 | 19.5 | 7.4 | 1.8 | 0.4 | 3.05 | 2.62 | 0.4 | 3.6 | 9- 1-48 |
| STL-2 S-3 | St. Joseph, Mo. | 0 | Nat. | 155 | 146 | 4750 | 4708 | 100 | 4.85 | 3.1 | 13.4 | 15.1 | 25.0 | 24.0 | 14.3 | 3.7 | 1.4 | 2.83 | 2.85 | 1.0 | 16.3 | 3- 1-48 |
| STP-3 S-1 | Detroit Lakes, Minn. | 1 | Nat. | 106 | 117 | 3075 | 4858 | 95 | 3.57 | 0.4 | 5.9 | 18.5 | 32.8 | 30.8 | 9.1 | 1.5 | 1.0 | 2.75 | 2.63 | 1.1 | 7.4 | 3-16-48 |
| STP-3 S-2 | Melvin, Minn. | 1 | Nat. | 125 | 124 | 3633 | 5150 | 100 | 3.82 | 1.8 | 17.7 | 23.2 | 21.7 | 20.1 | 12.9 | 0.9 | 1.7 | 3.10 | 2.64 | 1.6 | 10.9 | 3-17-48 |
| STP-3 S-3 | Grand Forks County, S. D. | 1 | Nat. | 117 | 122 | 3417 | 5083 | 102 | 3.63 | 0.1 | 10.1 | 29.1 | 23.0 | 18.7 | 15.6 | 2.3 | 1.1 | 2.90 | 2.64 | 1.1 | 10.2 | 3-16-48 |
| STP-4 G-1(A+D)(S) | Thief River Falls, Minn. | 1 | Nat. | 123 | 134 | 2875 | 4083 | 104 | 4.37 | 2.2 | 10.7 | 16.5 | 25.1 | 29.5 | 12.5 | 2.0 | 1.5 | 2.80 | 2.65 | 1.0 | 12.1 | 3-29-48 |
| STP-5 S-1 | Shell Rock, Iowa | 1 | Nat. | 112 | 114 | 3150 | 4175 | 97 | 3.99 | 1.6 | 7.5 | 17.1 | 31.8 | 32.2 | 8.9 | 0.6 | 0.3 | 2.84 | 2.63 | 0.8 | 3.4 | 4- 6-48 |
| STP-5 S-2 | Clear Lake, Iowa | 1 | Nat. | 90 | 99 | 2533 | 3617 | 98 | 3.92 | 0.0 | 11.7 | 21.0 | 24.2 | 27.3 | 14.3 | 1.0 | 0.5 | 2.84 | 2.61 | 1.5 | 10.6 | 3-25-48 |
| STP-5 S-3 | Decorah, Iowa | 1 | Nat. | 110 | 123 | 3075 | 4475 | 95 | 4.09 | 1.3 | 9.2 | 16.6 | 35.4 | 30.7 | 5.8 | 0.8 | 0.2 | 2.94 | 2.64 | 0.6 | 3.5 | 4-12-48 |
| STP-5 S-4 | Prairie Du Chien, Wis. | 1 | Nat. | 104 | 119 | 2917 | 4325 | 95 | 3.80 | 2.3 | 5.8 | 8.2 | 24.5 | 34.8 | 21.8 | 1.6 | 1.0 | 2.41 | 2.66 | 0.9 | 2.6 | 3-31-48 |
| STP-5 S-5 | Decorah, Iowa | 1 | Nat. | 115 | 112 | 3408 | 4533 | 102 | 3.80 | 2.5 | 9.2 | 16.3 | 28.0 | 33.6 | 9.5 | 0.6 | 0.3 | 2.87 | 2.62 | 1.0 | 6.5 | 4-12-48 |
| STP-5 S-6 | Winona, Minn. | 1 | Nat. | 122 | 127 | 2850 | 3884 | 102 | 4.60 | 0.2 | 7.7 | 15.4 | 29.7 | 38.7 | 7.8 | 0.3 | 0.2 | 2.76 | 2.67 | 0.7 | 4.3 | 4- 5-48 |
| STP-6 S-2 | Hastings, Minn. | 1 | Nat. | 137 | 145 | 3358 | 4758 | 98 | 3.50 | 0.2 | 7.2 | 25.2 | 33.2 | 25.2 | 5.8 | 1.8 | 1.4 | 2.94 | 2.64 | 0.8 | 5.1 | 4-26-48 |
| STP-6 S-3 | Hager City, Wis. | 1 | Nat. | 138 | 139 | 3383 | 4575 | 95 | 3.50 | 0.8 | 4.9 | 13.6 | 34.0 | 33.7 | 7.4 | 3.8 | 2.3 | 2.79 | 2.66 | 0.8 | 4.3 | 5- 2-48 |
| STP-7 S-1 | St. Paul, Minn. | 1 | Nat. | 92 | 116 | 2708 | 3533 | 100 | 4.69 | 2.4 | 9.1 | 15.8 | 27.1 | 35.9 | 8.8 | 0.7 | 0.2 | 2.85 | 2.66 | 0.7 | 4.3 | 6- 1-48 |
| VICKS-1 G-5 (3)(S) | Murfreesboro, Ark. | --- | Mfg. | 112 | 120 | 3242 | 4700 | 94 | 3.50 | 0.0 | 6.7 | 15.7 | 30.8 | 30.3 | 13.4 | 2.2 | 0.9 | 2.63 | 2.58 | 1.4 | 8.1 | 9-27-48 |
| VICKS-2 S-2 | Glazypeau Creek, Ark. | 5+ | Nat. | 117 | 115 | 2808 | 3658 | 102 | 2.80 | 0.0 | 17.2 | 22.7 | 15.3 | 14.8 | 8.9 | 6.6 | 14.5 | 2.61 | 2.48 | 2.8 | 16.1 | 2-17-48 |
| VICKS-2 S-4 | Malvern, Ark. | 2 | Nat. | 113 | 112 | 3417 | 4383 | 100 | 4.88 | 0.0 | 11.7 | 18.7 | 19.2 | 33.8 | 13.7 | 2.0 | 0.9 | 2.72 | 2.58 | 1.3 | 5.7 | 12- 8-48 |
| WES-1 S-2(4) | Georgetown, Miss. | 2 | Nat. | 116 | 115 | 2492 | 3975 | 95 | 4.62 | 1.2 | 4.3 | 10.2 | 21.8 | 46.5 | 14.1 | 1.5 | 0.4 | 2.42 | 2.63 | 0.3 | 2.1 | 6-19-48 |
| BA-1 S-1 | Vestal, N. Y. | 1 | Nat. | 102 | 107 | 3100 | 3883 | 104 | 4.12 | 3.1 | 14.6 | 9.8 | 19.3 | 40.1 | 9.9 | 1.6 | 1.6 | 2.79 | 2.62 | 1.7 | 15.6 | 12-30-48 |
| BUF-4 G-2(4&5)(S) | Leroy, N. Y. | --- | Mfg. | 137 | 137 | 3717 | 5300 | 104 | 3.66 | 0.0 | 10.6 | 18.5 | 26.2 | 20.2 | 16.1 | 6.9 | 1.5 | 2.52 | 2.64 | 0.8 | 12.3 | 3- 1-49 |
| BUF-4 G-2(10)(A)(S) | Leroy, N. Y. | --- | Mfg. | 117 | 127 | 3600 | 4941 | 94 | 3.26 | 0.0 | 36.5 | 25.0 | 14.2 | 8.8 | 5.1 | 4.0 | 6.4 | 3.48 | 2.62 | 1.0 | 5.7 | 5-29-49 |
| BUF-4 G-2(10)(B)(S) | Leroy, N. Y. | --- | Mfg. | 120 | 122 | 3700 | 4766 | 100 | 3.64 | 0.0 | 35.8 | 24.7 | 14.5 | 9.4 | 5.4 | 4.6 | 5.6 | 3.46 | 2.59 | 0.8 | 2.4 | 5-29-49 |
| BUF-4 G-2(12)(A)(S) | Leroy, N. Y. | --- | Mfg. | 115 | 117 | 3550 | 4550 | 92 | 3.12 | 0.0 | 40.3 | 23.7 | 13.1 | 8.2 | 4.7 | 4.0 | 6.0 | 3.57 | 2.61 | 1.0 | 6.7 | 5-26-49 |
| BUF-4 G-2(12)(B)(S) | Leroy, N. Y. | --- | Mfg. | 116 | 119 | 3591 | 4622 | 100 | 3.72 | 0.0 | 43.7 | 23.9 | 12.5 | 7.6 | 4.1 | 3.6 | 4.6 | 3.71 | 2.59 | 1.4 | 3.7 | 5-26-49 |
| BUF-7 S-1 | Vestal, N. Y. | 1 | Nat | 110 | 114 | 3242 | 4200 | 96 | 4.50 | 3.4 | 10.6 | 6.4 | 14.5 | 54.5 | 8.3 | 0.9 | 1.4 | 2.60 | 2.63 | 1.4 | 19.7 | 12-30-48 |
| BUF-7 S-2 | Elmira, N. Y. | 1 | Nat. | 102 | 117 | 3025 | 4308 | 102 | 3.96 | 2.0 | 13.4 | 15.4 | 25.2 | 29.2 | 9.3 | 2.4 | 3.1 | 2.84 | 2.61 | 1.8 | 11.5 | 12-30-48 |
| BUF-7 S-3 | Horseheads, N. Y. | 1 | Nat. | 108 | 103 | 3017 | 4150 | 100 | 4.32 | 0.0 | 20.2 | 24.9 | 28.3 | 19.0 | 4.2 | 1.1 | 2.3 | 3.28 | 2.61 | 2.3 | 20.1 | 12-30-48 |
| BUF-7 S-4 | Buttermilk Falls, N. Y. | 1 | Mfg. | 125 | 120 | 3517 | 4833 | 102 | 4.38 | 2.4 | 9.7 | 17.0 | 20.8 | 29.4 | 16.4 | 2.9 | 1.4 | 2.69 | 2.64 | 1.4 | 14.3 | 12-30-48 |
| BUF-7 S-5 | Ithaca, N. Y. | 1 | Nat. | 109 | 120 | 3311 | 4350 | 100 | 4.24 | 0.0 | 4.2 | 23.6 | 25.0 | 23.0 | 16.2 | 5.7 | 2.3 | 2.53 | 2.62 | 2.1 | 16.1 | 12-30-48 |
| BUF-7 S-6 | Oaks Corners, N. Y. | 1 | Nat. | 101 | 105 | 3375 | 3800 | 100 | 3.64 | 1.4 | 4.2 | 3.7 | 18.2 | 61.8 | 7.9 | 1.4 | 1.4 | 2.30 | 2.58 | 2.2 | 18.9 | 12-30-48 |

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Table 1 (Continued)



| CRD No. | Source | Organic Color, Fig. | Type | Strength Per Cent 3 Day | Strength Per Cent 7 Day | Compressive Strength, psi 3 Day | Compressive Strength, psi 7 Day | Flow % | Sand lb | Sieve Analysis Individual % Retained 4 | 8 | 16 | 30 | 50 | 100 | 200 | Pan | F.M. | Sp Gr | Abs. % | $MgSO_4$ Loss % | Date Rec'd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHI-1 S-1 | Pekin, Ill. | 3 | Nat. | 118 | 109 | 3317 | 4483 | 102 | 4.62 | 0.0 | 8.1 | 22.7 | 33.8 | 32.0 | 2.9 | 0.2 | 0.3 | 3.00 | 2.62 | 1.3 | 10.7 | 12-27-48 |
| CHI-1 S-2 | Pekin, Ill. | 2 | Nat. | 123 | 112 | 3433 | 4608 | 104 | 4.56 | 5.5 | 8.7 | 11.6 | 16.2 | 43.7 | 13.1 | 0.7 | 0.5 | 2.72 | 2.61 | 1.3 | 8.7 | 12-27-48 |
| CHI-2 S-1 | Harvey, Ill. | 1 | Nat. | 126 | 134 | 3467 | 4508 | 100 | 4.46 | 4.8 | 14.0 | 21.3 | 29.9 | 24.5 | 4.9 | 0.3 | 0.3 | 3.28 | 2.66 | 1.9 | 12.1 | 12-27-48 |
| CRD S-4(5) | Georgetown, Miss. | 2 | Nat. | 118 | 109 | 3300 | 4175 | 100 | 4.90 | 3.3 | 11.0 | 13.6 | 23.9 | 39.4 | 7.9 | 0.8 | 0.1 | 2.88 | 2.61 | 0.7 | 2.0 | 4-25-49 |
| CRD S-4(2) | Georgetown, Miss. | 2 | Nat. | 118 | 109 | 3300 | 4175 | 100 | 4.90 | 3.3 | 11.0 | 13.6 | 23.9 | 39.4 | 7.9 | 0.8 | 0.1 | 2.88 | 2.61 | 0.7 | 2.0 | 4-25-49 |
| GAL-1 S-2(2) | Texarkana, Tex. | 3 | Nat. | 108 | 109 | 3050 | 4083 | 102 | 5.00 | 1.9 | 10.8 | 13.8 | 21.1 | 39.6 | 10.4 | 2.2 | 0.2 | 2.24 | 2.60 | 0.4 | 2.5 | 5-16-49 |
| GAL-1 S-3(3) | Minden, La. | 1 | Nat. | 111 | 116 | 3156 | 4350 | 102 | 4.62 | 1.0 | 12.1 | 10.7 | 13.1 | 41.6 | 17.6 | 3.6 | 0.3 | 2.49 | 2.62 | 0.2 | 3.1 | 5-11-49 |
| LR-1 G-69(2)(S) | Flippin, Ark. | --- | Mfg. | 112 | 116 | 3658 | 4700 | 102 | 3.20 | 2.1 | 17.3 | 23.5 | 13.2 | 15.3 | 12.2 | 6.1 | 10.3 | 2.76 | 2.69 | 1.6 | 10.4 | 6-13-49 |
| MEM-6 S-1 | Dexter, Mo. | 1 | Nat. | 110 | 103 | 3383 | 4142 | 100 | 5.00 | 0.0 | 6.0 | 24.3 | 35.2 | 26.1 | 6.3 | 1.6 | 0.5 | 2.91 | 2.60 | 0.6 | 1.8 | 1-28-49 |
| MEM-8 S-1 | Cairo, Ill. | 4 | Nat. | 109 | 122 | 3367 | 4558 | 104 | 4.36 | 2.5 | 8.7 | 12.9 | 28.9 | 43.3 | 3.0 | 0.3 | 0.4 | 2.86 | 2.59 | 1.0 | 3.3 | 7- 5-49 |
| MEM-9 S-1 | Hickman, Ky. | 5 | Nat. | 102 | 104 | 3325 | 4208 | 105 | 4.80 | 5.1 | 12.7 | 16.7 | 25.2 | 32.6 | 6.9 | 0.7 | 0.1 | 3.09 | 2.61 | 0.6 | 2.8 | 7- 5-49 |
| NO-2 S-3 | Cole, La. | 1 | Nat. | 101 | 115 | 3125 | 4300 | 105 | 4.78 | 13.4 | 19.0 | 10.3 | 13.1 | 36.4 | 6.0 | 0.4 | 1.4 | 3.35 | 2.59 | 0.9 | --- | 7-11-49 |
| NO-8 S-1 | Segrue, La. | 1 | Nat. | 139 | 125 | 3717 | 4433 | 104 | 4.16 | 3.4 | 5.6 | 5.1 | 14.5 | 56.8 | 13.7 | 0.6 | 0.3 | 2.40 | 2.62 | 0.4 | 2.7 | 3-25-49 |
| NO-9 G-2(S) | Jena, La. | 2 | Nat. | 108 | 115 | 2992 | 4150 | 102 | 4.78 | 0.3 | 22.3 | 15.1 | 23.4 | 31.4 | 5.7 | 1.6 | 0.2 | 3.12 | 2.59 | 0.9 | 3.7 | 4-13-49 |
| NO-9 S-1 | Sicily Island, La. | 1 | Nat. | 125 | 126 | 3492 | 4558 | 102 | 3.88 | 0.6 | 5.2 | 6.2 | 24.9 | 51.0 | 7.4 | 2.8 | 1.9 | 2.39 | 2.60 | 0.8 | 1.1 | 4-11-49 |
| NO-9 S-2 | Jena, La. | 1 | Nat. | 111 | 112 | 3092 | 4133 | 104 | 3.54 | 0.0 | 2.7 | 2.6 | 23.1 | 62.0 | 3.8 | 0.8 | 5.0 | 2.21 | 2.62 | 0.2 | 0.6 | 3-13-49 |
| NO-9 S-3 | Wisner, La. | 2 | Nat. | 125 | 121 | 3483 | 4392 | 98 | 4.48 | 0.7 | 7.9 | 9.4 | 25.4 | 50.9 | 4.5 | 0.5 | 0.7 | 2.64 | 2.61 | 0.5 | 2.2 | 3-15-49 |
| NO-9 S-4 | Harrisonburg, La. | 3 | Nat. | 102 | 106 | 2817 | 3850 | 100 | 4.24 | 0.0 | 0.2 | 3.8 | 36.6 | 50.5 | 6.2 | 1.9 | 0.8 | 2.33 | 2.63 | 0.8 | 1.4 | 3-15-49 |
| NO-9 S-5 | Jena, La. | 1 | Nat. | 117 | 115 | 3258 | 4150 | 102 | 4.58 | 0.7 | 6.4 | 10.5 | 24.8 | 48.7 | 8.7 | 0.2 | 0.0 | 2.59 | 2.61 | 0.4 | 2.8 | 4-15-49 |
| NO-10 S-1 | Little River, Ark. | 2 | Nat. | 125 | 131 | 3500 | 5033 | 100 | 4.64 | 0.3 | 11.1 | 16.8 | 14.4 | 36.3 | 16.7 | 3.9 | 0.5 | 2.57 | 2.61 | 0.4 | 3.5 | 5-11-49 |
| NO-10 S-2 | Minden, La. | 1 | Nat. | 127 | 132 | 3592 | 4767 | 100 | 4.48 | 2.4 | 11.3 | 11.9 | 13.5 | 32.0 | 25.2 | 3.3 | 0.4 | 2.48 | 2.62 | 0.3 | 1.7 | 5-11-49 |
| NO-10 S-3 | Little River, Ark. | 1 | Nat. | 117 | 123 | 3300 | 4467 | 100 | 4.74 | 1.2 | 8.2 | 12.1 | 17.9 | 44.0 | 14.6 | 1.8 | 0.2 | 2.53 | 2.62 | 0.4 | 2.6 | 5-11-49 |
| NO-10 S-4 | Lewisville, Ark. | 2 | Nat. | 135 | 137 | 3800 | 4967 | 98 | 4.56 | 1.8 | 12.1 | 14.5 | 17.0 | 36.6 | 14.4 | 2.4 | 1.2 | 2.68 | 2.59 | 0.7 | 6.0 | 5-11-49 |
| NO-10 S-5 | Atlanta, Texas | 1 | Nat. | 112 | 113 | 3150 | 4083 | 98 | 4.46 | 0.0 | 1.7 | 13.2 | 22.8 | 54.6 | 7.6 | 0.4 | 0.1 | 2.46 | 2.62 | 0.3 | 2.0 | 5-11-49 |
| NO-10 S-6 | Heflin, La. | 1 | Nat. | 116 | 111 | 3300 | 4175 | 100 | 4.57 | 0.6 | 9.8 | 19.2 | 16.6 | 38.6 | 11.4 | 2.0 | 1.8 | 2.68 | 2.61 | 0.5 | 3.4 | 5-11-49 |
| NO-10 S-7 | Sibley, La. | 2 | Nat. | 123 | 118 | 3433 | 4517 | 100 | 4.26 | 0.3 | 4.4 | 5.4 | 12.3 | 47.0 | 21.3 | 5.5 | 3.8 | 1.98 | 2.62 | 0.4 | 2.2 | 5-11-49 |
| NO-10 S-8 | Texarkana, Tex. | 1 | Nat. | 118 | 116 | 3408 | 4467 | 104 | 4.64 | 2.6 | 8.4 | 8.3 | 12.4 | 38.6 | 18.1 | 10.1 | 1.5 | 2.23 | 2.62 | 0.3 | 2.5 | 5-11-49 |
| NO-10 S-9 | Little River, Ark. | 2 | Nat. | 127 | 131 | 3600 | 4908 | 98 | 4.74 | 3.5 | 14.2 | 10.8 | 9.0 | 30.3 | 27.0 | 4.6 | 0.6 | 2.50 | 2.61 | 0.3 | 2.8 | 5-11-49 |
| NO-11 S-1 | Alexandria, La. | 1 | Nat. | 102 | 106 | 3008 | 4100 | 100 | 5.00 | 12.9 | 16.1 | 10.5 | 10.3 | 36.9 | 11.7 | 1.3 | 0.3 | 3.16 | 2.59 | 0.7 | 1.3 | 5-11-49 |
| NO-11 S-2 | Monroe, La. | 1 | Nat. | 106 | 101 | 3117 | 3908 | 98 | 4.26 | 0.6 | 3.6 | 8.9 | 18.5 | 45.3 | 20.1 | 2.4 | 0.6 | 2.23 | 2.60 | 0.8 | 5.8 | 6-14-49 |
| NO-11 S-3 | Pollock, La. | 1 | Nat. | 110 | 118 | 2333 | 4550 | 102 | 4.26 | 0.0 | 7.4 | 12.8 | 25.7 | 42.1 | 9.5 | 1.6 | 0.9 | 2.59 | 2.60 | 0.7 | 2.1 | 6-15-49 |
| NO-12 S-1 | Amite, La. | 1 | Nat. | 113 | 106 | 3317 | 4075 | 100 | 4.20 | 0.4 | 4.8 | 7.3 | 12.7 | 52.5 | 19.2 | 2.6 | 0.5 | 2.18 | 2.61 | 0.3 | 3.3 | 6-15-49 |
| NO-12 S-2 | Amite, La. | 2 | Nat. | 105 | 105 | 3442 | 4267 | 104 | 4.78 | 1.5 | 12.5 | 16.8 | 18.4 | 35.6 | 13.3 | 1.6 | 0.3 | 2.78 | 2.60 | 0.5 | 2.8 | 6-30-49 |
| NOR-2 G-4(S)(S)&(SA) | Buchanan, Va. | --- | Mfg. | 147 | 127 | 4117 | 5108 | 102 | 4.54 | 0.0 | 14.3 | 20.9 | 29.3 | 15.1 | 12.3 | 3.7 | 4.4 | 2.86 | 2.80 | 1.5 | 2.2 | 1-24-49 |
| NOR-2 G-4(S)(7) | Buchanan, Va. | --- | Mfg. | 121 | 121 | 3658 | 5150 | 103 | 3.00 | 0.0 | 0.2 | 8.1 | 25.0 | 15.7 | 11.3 | 12.3 | 27.4 | 1.51 | 2.83 | 0.5 | 1.9 | 3-26-49 |
| NOR-2 G-5(S)(2) | Radford, Va. | --- | Mfg. | 136 | 141 | 3667 | 4817 | 104 | 4.40 | 0.0 | 9.8 | 27.1 | 23.0 | 17.2 | 15.1 | 5.5 | 2.4 | 2.76 | 2.79 | 0.4 | 2.0 | 12-27-48 |
| NOR-2 G-6(S)(2) | Pembroke, Va. | --- | Mfg. | 131 | 136 | 3883 | 5000 | 96 | 4.50 | 0.0 | 9.7 | 23.7 | 30.3 | 18.1 | 10.1 | 3.3 | 4.8 | 2.81 | 2.79 | 0.7 | 5.4 | 12-27-48 |
| NOR-2 S-1(2) | | | | | | | | | | | | | | | | | | | | | | |
| NOR-2 S-1(2)(A) | Chester, Va. | 1 | Nat. | 115 | 120 | 3408 | 4433 | 102 | 3.78 | 0.0 | 9.4 | 23.8 | 23.3 | 20.8 | 15.0 | 6.1 | 1.6 | 2.71 | 2.62 | 1.0 | 5.5 | 1- 3-49 |
| SAC-1 G-23(2)(S) | Kings River, Calif. | 2 | Nat. | 106 | 109 | 2858 | 3800 | 106 | 3.72 | 2.5 | 13.6 | 18.3 | 23.4 | 19.9 | 14.7 | 6.8 | 0.8 | 2.81 | 2.66 | 1.4 | 10.6 | 2-28-49 |
| SAC-1 G-23(2)(4)(3)(S) | Kings River, Calif. | 4 | Nat. | 106 | 109 | 2858 | 3800 | 106 | 3.72 | 8.3 | 7.6 | 10.4 | 15.1 | 18.0 | 20.7 | 13.8 | 6.1 | 2.31 | 2.66 | 1.4 | 8.1 | 5-18-49 |
| STL-2 G-1(5)(S) | Falling Springs, Ill. | --- | Mfg. | 121 | 121 | 3417 | 4350 | 102 | 3.58 | 0.0 | 7.2 | 14.2 | 31.2 | 29.0 | 13.3 | 3.9 | 1.2 | 2.58 | 2.64 | 1.6 | 17.9 | 3- 1-49 |
| STL-2 G-1(6)(S) | Falling Springs, Ill. | --- | Mfg. | 128 | 135 | 3983 | 5067 | 100 | 2.20 | 0.0 | 12.4 | 20.8 | 21.4 | 16.0 | 9.5 | 7.0 | 12.9 | 2.51 | 2.61 | 2.1 | 12.0 | 7- 6-49 |
| STL-2 G-6(S)(A) | Thornton, Ill. | --- | Mfg. | 116 | 124 | 3308 | 4692 | 102 | 3.04 | 3.8 | 9.8 | 33.1 | 22.7 | 15.5 | 10.4 | 3.1 | 1.6 | 3.14 | 2.70 | 1.7 | 12.4 | 9-28-48 |
| STL-2 G-7(S) | Elsberry, Mo. | --- | Mfg. | 121 | 123 | 3984 | 5458 | 102 | 3.40 | 0.0 | 1.9 | 22.0 | 21.4 | 17.1 | 14.3 | 8.3 | 15.0 | 2.10 | 2.59 | 2.3 | 17.6 | 10-11-48 |
| STL-2 G-7(S)(A) | Elsberry, Mo. | --- | Mfg. | 121 | 123 | 3984 | 5458 | 102 | 3.40 | 0.0 | 12.0 | 67.1 | 17.3 | 0.7 | 0.4 | 0.6 | 1.9 | 3.82 | 2.58 | 2.4 | 14.7 | 10-11-48 |
| STL-2 S-1(2) | St. Louis, Mo. | --- | Mfg. | 117 | 130 | 3575 | 4183 | 98 | 6.11 | 0.7 | 10.7 | 23.9 | 37.6 | 15.0 | 8.0 | 3.9 | 0.2 | 3.04 | 2.62 | 0.5 | 5.1 | 3- 3-49 |
| VICKS-2 S-4(2) | Malvern, Ark. | 2 | Nat. | 123 | 120 | 3267 | 4250 | 98 | 3.68 | 0.1 | 5.6 | 11.5 | 17.7 | 45.8 | 16.7 | 1.8 | 0.8 | 2.36 | 2.57 | 1.9 | 10.3 | 3- 9-49 |
| VICKS-2 S-5 | Little Rock, Ark. | 1 | Nat. | 112 | 110 | 3000 | 3892 | 102 | 4.68 | 2.3 | 6.1 | 20.1 | 41.9 | 27.0 | 1.8 | 0.7 | 0.1 | 3.06 | 2.62 | 0.5 | 3.8 | 3-16-49 |
| VICKS-2 S-6 | Arkadelphia, Ark. | 2 | Nat. | 111 | 107 | 3350 | 4567 | 95 | 4.30 | 3.2 | 13.0 | 12.9 | 12.9 | 30.6 | 20.1 | 5.7 | 1.6 | 2.56 | 2.59 | 1.3 | 3.8 | 3-11-49 |
| VICKS-3 S-2 | Dugger, Miss. | 1 | Nat. | 113 | 116 | 3491 | 4541 | 96 | 5.00 | 1.1 | 15.3 | 21.8 | 20.1 | 19.8 | 17.9 | 3.2 | 0.8 | 2.88 | 2.60 | 0.8 | 3.1 | 6-15-49 |
| VICKS-4 S-1 | Grenada, Miss. | 1 | Nat. | 98 | 130 | 3283 | 4350 | 98 | 4.52 | 0.4 | 8.1 | 16.9 | 27.0 | 43.5 | 3.7 | 0.2 | 0.2 | 2.82 | 2.61 | 0.6 | 2.0 | 12-29-48 |
| VICKS-7 S-1 | Port Gibson, Miss. | 2 | Nat. | 95 | 94 | 3142 | 3842 | 95 | 5.30 | 6.3 | 9.4 | 22.4 | 41.1 | 16.1 | 4.1 | 0.5 | 0.1 | 3.34 | 2.60 | 0.5 | 2.0 | 12-21-48 |
| VICKS-7 S-2 | Utica, Miss. | 1 | Nat. | 115 | 110 | 3233 | 4542 | 104 | 4.68 | 6.5 | 10.5 | 11.2 | 19.6 | 41.7 | 8.5 | 0.3 | 1.7 | 2.87 | 2.61 | 0.5 | 2.3 | 12-21-48 |
| VICKS-7 S-3 | Yazoo City, Miss. | 1 | Nat. | 101 | 118 | 2675 | 3658 | 100 | 4.06 | 0.6 | 3.0 | 7.9 | 21.2 | 58.7 | 7.8 | 0.2 | 0.6 | 2.39 | 2.63 | 0.4 | 2.6 | 12-24-48 |
| VICKS-7 S-4 | Yazoo City, Miss. | 1 | Nat. | 114 | 126 | 3017 | 3917 | 102 | 5.00 | 8.5 | 13.0 | 9.4 | 11.3 | 45.5 | 11.6 | 0.3 | 0.4 | 2.90 | 2.60 | 0.5 | 3.8 | 12-24-48 |
| VICKS-7 S-5 | Natchez, Miss. | 2 | Nat. | 118 | 129 | 3133 | 4008 | 104 | 4.18 | 1.2 | 7.4 | 9.7 | 14.6 | 54.6 | 10.8 | 0.9 | 0.8 | 2.47 | 2.62 | 0.4 | 2.9 | 12-29-48 |
| VICKS-7 S-6 | Vicksburg, Miss. | 1 | Nat. | 122 | 122 | 3292 | 4175 | 104 | 4.18 | 2.6 | 7.0 | 7.2 | 17.8 | 47.5 | 16.6 | 1.1 | 0.2 | 2.44 | 2.61 | 0.4 | 2.8 | 1-10-49 |
| WW-1 S-1 | McNary, Ore.-Wash. | 1 | Nat. | 114 | 124 | 3217 | 4450 | 104 | 4.32 | 0.6 | 12.7 | 12.4 | 19.9 | 26.3 | 21.2 | 4.3 | 2.6 | 2.50 | 2.69 | 1.8 | 8.1 | 3-17-49 |
| WW-1 S-2 | McNary, Ore.-Wash. | 1 | Nat. | 110 | 117 | 3100 | 4225 | 98 | 4.22 | 0.0 | 10.9 | 17.2 | 25.3 | 22.0 | 17.1 | 5.1 | 2.4 | 2.60 | 2.69 | 1.7 | 9.0 | 3-17-49 |

TABLE II.—EFFECTS OF MOISTURE CONDITION OF SAND ON COMPRESSIVE STRENGTH OF MORTAR.

| Round | Oven-Dry Sand | | | | Saturated Surface-Dry Sand | | | | Sand with Water of Absorption Added ½ hr before Mixing of Mortar | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Compressive Strength, psi | | Sand Used, lb | Flow, per cent | Compressive Strength, psi | | Sand Used, lb | Flow, per cent | Compressive Strength psi | | Sand Used, lb | Flow, per cent |
| | 3-Day | 7-Day | | | 3-Day | 7-Day | | | 3-Day | 7-Day | | |
| 3.... | 3183 | 5425 | 3.51 | 100 | 2742 | 4783 | 3.50 | 104 | 2908 | 4708 | 3.56 | 102 |
| 4.... | 2725 | 4767 | 3.45 | 99 | 2550 | 4767 | 3.68 | 102 | 2808 | 5125 | 3.42 | 104 |
| 5.... | 2689 | 3717 | 3.32 | 97 | 2704 | 3967 | 3.51 | 99 | 2758 | 4283 | 3.28 | 100 |
| 6.... | 2683 | 4500 | 3.32 | 95 | 2375 | 3825 | 3.29 | 98 | 2600 | 4417 | 2.99 | 103 |
| 7.... | 2250 | 3575 | 3.32 | 100 | 2317 | 3275 | 3.31 | 98 | 2275 | 3242 | 3.49 | 95 |
| 8.... | 2562 | 3833 | 3.25 | 97 | 2300 | 3883 | 3.13 | 103 | 2554 | 3975 | 3.39 | 95 |
| Avg.... | 2682 | 4303 | 3.36 | 98.0 | 2496 | 4083 | 3.40 | 100.7 | 2650 | 4292 | 3.36 | 99.8 |

*Effect of Moisture Condition of Sand on Strength:*

One other possible source of variation in results of compressive strength tests of mortar specimens is the moisture condition of the sand used in making the mortar. A limited investigation of this factor was made using standard Ottawa sand. Mortars were made on two consecutive days using standard Ottawa sand in the following three conditions: (1) oven-dry; (2) saturated surface-dry; (3) water of absorption added ½ hr prior to mixing of mortar. Cubes were made for test at 3 and 7 days with the results shown in the tabulation below:

| Round | Oven-Dry Sand | | | | Saturated Surface-Dry Sand | | | | Sand with Water of Absorption Added ½ hr before Mixing of Mortar | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Compressive Strength, psi | | Sand Used, lb | Flow, per cent | Compressive Strength, psi | | Sand Used, lb | Flow, per cent | Compressive Strength, psi | | Sand Used, lb | Flow, per cent |
| | 3-Day | 7-Day | | | 3-Day | 7-Day | | | 3-Day | 7-Day | | |
| 1.... | 1283 | 2642 | 3.97 | 100 | 1352 | 2600 | 4.05 | 102 | 1362 | 2683 | 4.01 | 96 |
| 2.... | 2233 | 4408 | 3.84 | 100 | 1267 | 2450 | 3.98 | 97 | 2210 | 3850 | 3.91 | 96 |

These results, however, failed to indicate a significant variation in strength as a function of the variables being investigated (moisture condition of sand).

A second group involving six additional rounds of tests was investigated. A type III cement was used in preparing the specimens, all of which were prepared and tested according to procedures of ASTM Method C 87 and applicable portions of ASTM Method C 109[7] except with regard to the variable moisture condition of sand. Figure 5 and Table II show the characteristics of the mortar and the strengths developed by the cubes. These more extensive data indicate that round-to-round variation is still very marked, strength variation in any one round as affected by moisture condition being much less than the variation between strengths from round to round for a constant moisture condition, as shown in Fig. 6 and the following tabulation:

| Variation | Condition or Round | Strength Variation, psi | |
|---|---|---|---|
| | | 3-Day | 7-Day |
| Due to moisture condition, maximum range in each round | 3 | 441 | 717 |
| | 4 | 258 | 358 |
| | 5 | 69 | 566 |
| | 6 | 308 | 592 |
| | 7 | 42 | 333 |
| | 8 | 262 | 142 |
| From round to round for each moisture condition | Oven-dry | 993 | 1850 |
| | Saturated surface-dry | 442 | 1508 |
| | Water added | 633 | 1883 |

[7] Method of Test for Compressive Strength of Hydraulic-Cement Mortars (C 109 - 44), 1944 Book of ASTM Standards, Part II, p. 76.

TABLE III.

| Fineness Modulus | Compressive Strength, psi | | Flow | Sand, lb | Strength, per cent | |
|---|---|---|---|---|---|---|
| | 3-Day | 7-Day | | | 3-Day | 7-Day |
| MANUFACTURED SAND (BUF-4 6-2 (4) S) | | | | | | |
| 1.84..... | 3508 | 4858 | 100 | 3.26 | 132 | 144 |
| 2.04..... | 3452 | 4633 | 102 | 3.42 | 137 | 129 |
| 2.37..... | 2833 | 3850 | 102 | 3.68 | 107 | 114 |
| 2.44..... | 3575 | 4667 | 95 | 3.40 | 138 | 130 |
| 2.64..... | 3283 | 4667 | 104 | 3.20 | 124 | 138 |
| 2.81..... | 3567 | 4458 | 98 | 4.32 | 138 | 124 |
| 3.07..... | 3500 | 4692 | 98 | 4.50 | 136 | 130 |
| 3.28..... | 2825 | 4058 | 96 | 4.54 | 106 | 120 |
| Std[a]..... | 2658 | 3375 | 96 | 4.52 | 100 | 100 |
| Std[a]..... | 2583 | 3600 | 100 | 4.48 | 100 | 100 |
| NATURAL SAND (CRD STD) | | | | | | |
| 1.84..... | 3225 | 4400 | 104 | 3.82 | 121 | 131 |
| 2.04..... | 3183 | 4150 | 100 | 4.12 | 119 | 124 |
| 2.37..... | 2633 | 3575 | 98 | 4.52 | 104 | 100 |
| 2.44..... | 3283 | 4613 | 105 | 4.40 | 123 | 138 |
| 2.64..... | 3083 | 4242 | 102 | 5.00 | 115 | 127 |
| 2.81..... | 3167 | 4218 | 104 | 5.00 | 125 | 118 |
| 3.07..... | 2967 | 4117 | 102 | 5.38 | 118 | 115 |
| 3.28..... | 2858 | 3650 | 95 | 5.80 | 113 | 102 |
| Std[a]..... | 2525 | 3583 | 98 | 4.52 | 100 | 100 |
| Std[a]..... | 2675 | 3350 | 98 | 4.66 | 100 | 100 |

[a] 50 per cent graded, 50 per cent standard Ottawa, fineness modulus 2.37.

## SUMMARY

There are, no doubt, many other relationships among the data tabulated which could be investigated. However, it is suggested that the relationships indicated by the limited analyses performed serve to emphasize again the difficulty mentioned by Jackson in 1943, namely, that "a proper interpretation of results is difficult because of the many variables that influence the results" (1).

## REFERENCES


(1) F. H. Jackson, "Mortar Strength Tests of Fine Aggregate," "Report on Significance of Tests of Concrete and Concrete Aggregate," 2nd Edition, Am. Soc. Testing Mats., pp. 145–151 (1943). (Issued as separate publication *No. STP-22-A*.)

(2) Harold S. Sweet, "Physical and Chemical Tests of Mineral Aggregates and Their Significance," pp. 52–53 (1948). (Issued as separate publication *STP No. 83*.)

(3) Delmar L. Bloem, "Effect of Certain Variables on Results of Standard Mortar Tests of Fine Aggregate," ASTM BULLETIN, No. 178, December, 1951, p. 44 (TP238).

# Effect of Certain Variables on Results of Standard Mortar Test of Fine Aggregate

By Delmar L. Bloem[1]

ASTM Method C 87, Standard Method of Test for Measuring Mortar-Making Properties of Fine Aggregate was first published as Tentative in 1931 following extensive studies by Pearson (1)[2] of the strength of constant water-cement ratio mortars made with a large number of building sands. His work was prompted by the inadequacy of previously used methods for evaluating sands, the approach being suggested by Brickett's work (2) in developing a plastic mortar test for cement. The method was adopted as standard in 1936 and is at present used by many specification-writing bodies as one of the bases for acceptance or rejection of fine aggregate for use in concrete.

The scope of Method C 87 states that it is intended primarily to determine the effect of organic impurities in fine aggregates on the strength of mortar. Experience in testing sands by this method by the National Sand and Gravel Association Research Foundation and the Research Laboratory of the National Ready Mixed Concrete Assn. at the University of Maryland has indicated that variables within the test procedure may cause variation in strength of sufficient magnitude to conceal the effect of organic impurities. Other investigators (3, 4, 5) have also suggested that the test procedure may be inadequate for its intended purpose.

Two investigations were conducted. The first (series J-16) had for its purpose the determination of effect of sand grading on strength of plastic mortar of constant water-cement ratio; the second (series 116) was to determine if the relative mortar strength is affected by the use of different brands of cement.

These tests were conducted under the general supervision of Stanton Walker and Fred F. Bartel, Director of Engineering and former Assistant Director of Engineering, respectively, and under the immediate supervision of the author. E. J. Zeigler, Associate Research Engineer, assisted in the actual conduct of the tests.

## Test Procedures

All mortar for both investigations was mixed in accordance with ASTM Method C 87 – 47.[3] That is to say, the water-cement ratio was maintained at 0.6 by weight and the flow adjusted as nearly as practicable to 100 per cent by varying the sand content. Sands were brought to a saturated-surface-dry condition by adding water equivalent to their absorption at least 30 min before mixing. Specimens consisted of 2 by 4-in. cylinders molded in paraffin-impregnated cardboard containers. The molds were filled to overflowing and stored in the moist room at 70 F for 3 to 4 hr before being struck off; they remained in the moist room until stripped 20 to 24 hr after mixing, when they were stored in water. All specimens were capped on both ends with neat cement paste at the age of 3 or 4 days. Except for the few minutes required to apply the caps, cylinders were stored continuously in water at 70 F after stripping until tested at 7 or 28 days.

For series J-16 a high-quality quartz sand (lot 1935) was separated into seven sizes and recombined to produce the 6 gradings shown in Table I. All of these gradings, ranging from very coarse to very fine, fall within the over-all limits given in ASTM Standard Specifications for Concrete Aggregates (C33).[4] Sands Nos. 1, 3, and 6, however, fail to meet the intent of the specification that the sand be "well graded from coarse to fine." Each of these six sands, as well as graded standard Ottawa sand having a fineness modulus of 2.36, was used in the 0.6 water-cement ratio plastic mortar. Three batches of mortar were made on different days for each sand, and four cylinders molded from each batch for compressive strength tests at 28 days.

Series 116 consisted of tests of four different sands (including graded standard Ottawa) used with each of five different normal portland cements. Five batches of mortar were mixed on different days for each of the 20 sand-cement combinations. Four cylinders were molded from each batch, two for compressive strength tests at 7 days and two at 28 days.

## Discussion of Test Results

Physical characteristics and gradings of sands used in series J-16 are given in Table I. Characteristics of the fresh mortar and results of strength tests are shown in Table II.

The data in Table II indicate a good degree of mixing and testing control. Only in one case (sand no. 6) was the average flow outside the prescribed limits of 100 ± 5. In no case was the range in flow more than 7 for the three batches of a given type of mortar. The very low probable errors of average compressive strengths indicate the data to be dependable.

Some relationships suggested by the

TABLE I.—CHARACTERISTICS OF SANDS (SERIES J-16).

| | Grading, per cent retained | | | | | | |
|---|---|---|---|---|---|---|---|
| | Stock Sand—Lot 1935 | | | | | | Ottawa Sand[a]—Lots 1890 and 1930 |
| | No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 |
| Sieve size | | | | | | | |
| 3/8 in. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| No. 4 | 5 | 5 | 5 | 0 | 0 | 0 | 0 |
| No. 8 | 55 | 30 | 5 | 10 | 10 | 0 | 0 |
| No. 16 | 55 | 55 | 55 | 30 | 20 | 20 | 0 |
| No. 30 | 90 | 75 | 55 | 60 | 45 | 20 | 51 |
| No. 50 | 90 | 90 | 90 | 85 | 70 | 70 | 86 |
| No. 100 | 98 | 98 | 98 | 95 | 90 | 90 | 99 |
| Fineness modulus | 3.93 | 3.53 | 3.08 | 2.80 | 2.35 | 2.00 | 2.36 |
| Specific gravity, bulk dry | ... | ... | ... | 2.59 | ... | ... | 2.65 |
| Absorption, per cent | ... | ... | ... | 1.0 | ... | ... | Negligible |
| Organic impurities by colorimetric test | | | | None | | | None |

[a] 50 per cent standard No. 20 to 30 and 50 per cent graded.

Note.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Assistant Director of Engineering of National Sand and Gravel Assn. and National Ready Mixed Concrete Assn., Washington, D. C.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

[3] Method of Test for Measuring Mortar-Making Properties of Fine Aggregates (C 87 – 47) 1949 Book of ASTM Standards, Part 3, p. 754.

[4] 1949 Book of ASTM Standards, Part 3, p. 715.

data are shown in Figs. 1, 2, and 3. That the relative strength of mortar is affected by the fineness of the sand is apparent from Fig. 1. It will be noted that, as the sand became coarser, the strength of mortar decreased. The strengths of mortar made with various gradings of the same sand, expressed as percentages of the strength of Ottawa sand mortar, ranged from 109 per cent for the fine to only 94 per cent for the coarse. This wide variation suggests that fine sands have a decided advantage in plastic mortar strength tests quite unrelated to their organic content or the inherent strength of the particles.

A study of Figs. 2 and 3 suggests an explanation for the effect of fineness on mortar strength. As seen in Fig. 2, the quantity of a given sand required to produce a flow of 100 per cent is a straight-line function of the fineness modulus of the sand. The fact that the point for Ottawa sand lies far off the curve suggests that other characteristics such as particle shape and surface texture, and perhaps also particle distribution, affect the quantity of sand required.

Figure 3, showing the relationship between strength of mortar and quantity of sand, follows logically from the relationships given in Figs. 1 and 2. It would appear that the higher strengths of mortars containing fine sands may be attributed to the higher paste content of these mortars rather than to a direct relationship between fineness and strength. In other words, strength is reduced as the quantity of sand is increased because the volume of paste per unit volume of mortar is decreased. The effect of fineness, therefore, is indirect since it determines the quantity of sand required. The fact that the point for Ottawa sand mortar lines up well with points for lot 1935 sand in Fig. 3, but not in Fig. 1, lends support to this reasoning.

TABLE II.—MORTAR STRENGTH TEST RESULTS (SERIES J-16).

Mortar mixed and tested in accordance with ASTM Method C 87 – 47, "Standard Method of Test for Measuring Mortar-Making Properties of Fine Aggregate."

Sands Nos. 1 through 6 were the same except for gradings which were secured by separating into individual sizes and recombining. Sand 7 Ottawa sand, 50 per cent standard and 50 per cent graded.

For characteristics and gradings of sand, see Table I.

Each value for flow and air content average of three batches with same sand-cement ratio. Values for compressive strength are averages of twelve 2 by 4-in. cylinders, four from each batch.

| Sand | Fineness Modulus Sand | Flow, per cent | Ratio, Sand to Cement by Weight | Air[a] Content, per cent | 28-Day Compressive Strength | | |
|---|---|---|---|---|---|---|---|
| | | | | | psi | Per cent[b] | Probable Error, per cent[c] |
| No. 1.. | 3.93 | 96 | 3.89 | 1.9 | 4230 | 94 | 0.5 |
| No. 2.. | 3.53 | 105 | 3.42 | 2.5 | 4440 | 99 | 0.5 |
| No. 3.. | 3.08 | 103 | 3.05 | 2.4 | 4610 | 103 | 0.5 |
| No. 4.. | 2.80 | 103 | 2.76 | 2.7 | 4590 | 102 | 0.3 |
| No. 5.. | 2.35 | 102 | 2.34 | 2.3 | 4680 | 104 | 0.5 |
| No. 6.. | 2.00 | 106 | 2.08 | 1.9 | 4870 | 109 | 0.6 |
| No. 7.. | 2.36 | 104 | 3.14 | 3.9 | 4480 | 100 | 1.2 |

[a] Determined gravimetrically in a 275-cc container weighed to nearest 0.5 g.

[b] Per cent of strength of mortar made with Ottawa sand (No. 7).

[c] $p = \frac{0.6745}{\bar{x}} \sqrt{\frac{\Sigma x^2}{n(n-1)}}\ (100)$, where $x$ is average strength, $\bar{x}$ is deviation from the average, and $n$ is the number of tests, in this case 12.

TABLE III.—CHARACTERISTICS OF SANDS (SERIES 116).

| Sand | Lot | Specific Gravity, Bulk Dry | Absorption, per cent | Fineness Modulus | Organic Impurities, Colorimetric Test |
|---|---|---|---|---|---|
| No. 1..... | No. 1890 & 1930[a] | 2.65 | 0.0 | 2.40 | None |
| No. 2..... | 2059 | 2.59 | 1.0 | 2.80 | None |
| No. 3..... | 1873 | 2.53 | 2.6 | 2.85 | Trace |
| No. 4..... | 2031 | 2.57 | 1.8 | 2.52 | Trace |

[a] Ottawa sand, 50 per cent standard and 50 per cent graded.

Table III gives characteristics of sands used in series 116. Table IV shows characteristics of the fresh mortar and results of 7 and 28-day strength tests. As in series J-16, laboratory control of the mortar was good and results would appear to be dependable. Only in the case of mortar containing sand No. 4 with cements Nos. 1 and 3 did the flow deviate excessively from the 100 ± 5 range. These two mortars are not considered in discussing the data.

It is apparent from Table IV that the use of different cements produced considerable variation in the strength ratios of the mortars. The strengths of mortar expressed as percentages of the strength of that made with the same cement and Ottawa sand ranged as follows:

| | 7-Day Strength, per cent | 28-Day Strength, per cent |
|---|---|---|
| Sand No. 2 | 101 to 133 | 98 to 109 |
| Sand No. 3 | 92 to 104 | 94 to 99 |
| Sand No. 4 | 92 to 96[a] | 93 to 105[a] |

[a] Cements Nos. 1 and 3 omitted because of poor flow result; if included, range 86 to 113 at 7 days and 88 to 105 at 28 days.

It is interesting to note from Table IV that, in general, strength ratios for cement No. 5 which was a blend of equal parts of cements Nos. 1, 2, 3, and 4 agreed quite closely with the average of the ratios for cements Nos. 1, 2, 3, and 4. The lack of agreement in the case of 28-day tests made with sand No. 4 may be associated with the erratic flow test results for the combinations of cements Nos. 1 and 3 with this sand. The data suggest therefore that more reliable results may be obtainable in this test if a blend of several cements is used instead of a single brand. Even this procedure, however, would not insure that different blends would not give different results.

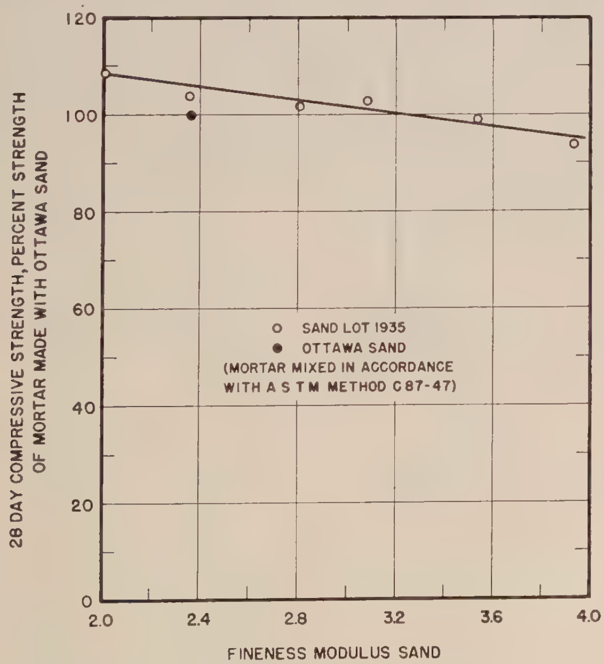


Fig. 1.—Effect of Fineness of Sand on Mortar Strength (Series J-16).

## Conclusions

The data from these investigations suggest that ASTM Method C 87 does not provide adequately for isolation of the principal variable which it is intended to measure, that is, the effect of organic impurities on strength of mortar. Characteristics of the sand, such as fineness and probably shape and surface texture, affect the quantity of sand required in the test, which, in turn, appears to bear a direct relationship to strength.

A wide range in relative strengths of mortars was found to result from the use of different brands of cement. It is possible, therefore, that a sand might fail to meet specification requirements with one cement but give entirely acceptable results with another.

## References


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(4) C. E. Thomas and S. H. Graf, "An Investigation of Some Oregon Sands," *Bulletin Series No. 8*, Oregon State College Engineering Experiment Station (1937).

(5) C. E. Thomas and S. H. Graf, "Ten-Year Mortar Strength Tests of Some Oregon Sands," *Bulletin Series No. 23*, Oregon State College Engineering Experiment Station (July, 1948).


TABLE IV.—MORTAR STRENGTH TEST RESULTS (SERIES 116).

Mortar mixed and tested in accordance with ASTM Method C 87 – 47, "Standard Method of Test for Measuring Mortar-Making Properties of Fine Aggregate."
For characteristics of sands, see Table III.
Each value of flow and sand-cement ratio average of five batches mixed on different days. Each value of strength average of ten 2 by 4-in. cylinders, two from each batch.

| Cement | Flow, per cent | Ratio, Sand to Cement, by Weight | 7-Day Tests: Compressive Strength, psi | 7-Day Tests: Compressive Strength, per cent[a] | 7-Day Tests: Probable Error, per cent[b] | 28-Day Tests: Compressive Strength, psi | 28-Day Tests: Compressive Strength, per cent[a] | 28-Day Tests: Probable Error, per cent[b] |
|---|---|---|---|---|---|---|---|---|
| **Sand No. 1 (Ottawa)—50 per cent Standard, 50 per cent Graded** | | | | | | | | |
| No. 1.... | 105 | 3.19 | 1920 | 100 | 1.3 | 4180 | 100 | 1.5 |
| No. 2.... | 98 | 3.19 | 2280 | 100 | 1.0 | 4330 | 100 | 1.1 |
| No. 3.... | 105 | 3.19 | 2580 | 100 | 1.3 | 4520 | 100 | 0.9 |
| No. 4.... | 100 | 3.04 | 2950 | 100 | 1.5 | 4900 | 100 | 1.6 |
| No. 5[c]... | 102 | 3.19 | 2520 | 100 | 1.1 | 4380 | 100 | 2.0 |
| Avg. of 1, 2, 3, 4 | 102 | ... | 2430 | 100 | ... | 4480 | 100 | ... |
| **Sand No. 2 (Lot 2059)** | | | | | | | | |
| No. 1.... | 102 | 3.19 | 2560 | 133 | 1.5 | 4570 | 109 | 1.0 |
| No. 2.... | 105 | 3.02 | 2520 | 111 | 1.7 | 4410 | 102 | 0.9 |
| No. 3.... | 107 | 3.19 | 2770 | 107 | 0.9 | 4580 | 101 | 1.4 |
| No. 4.... | 100 | 3.02 | 2980 | 101 | 1.0 | 4820 | 98 | 0.8 |
| No. 5[c]... | 98 | 3.19 | 2820 | 112 | 1.2 | 4700 | 107 | 0.9 |
| Avg. of 1, 2, 3, 4.. | 103 | ... | 2710 | 112 | ... | 4600 | 103 | ... |
| **Sand No. 3 (Lot 1873)** | | | | | | | | |
| No. 1.... | 107 | 3.33 | 1990 | 104 | 0.9 | 4120 | 99 | 1.0 |
| No. 2.... | 102 | 3.33 | 2220 | 97 | 1.7 | 4300 | 99 | 1.9 |
| No. 3.... | 100 | 3.50 | 2360 | 92 | 2.5 | 4270 | 94 | 1.5 |
| No. 4.... | 100 | 3.13 | 2700 | 92 | 2.2 | 4750 | 97 | 1.4 |
| No. 5[c]... | 105 | 3.33 | 2390 | 95 | 1.4 | 4310 | 98 | 2.0 |
| Avg. of 1, 2, 3, 4.. | 102 | ... | 2320 | 95 | ... | 4360 | 97 | ... |
| **Sand No. 4 (Lot 2031)** | | | | | | | | |
| No. 1.... | 110 | 2.67 | 2160 | 113 | 0.8 | 4260 | 102 | 1.0 |
| No. 2.... | 100 | 2.67 | 2180 | 96 | 1.5 | 4260 | 98 | 1.5 |
| No. 3.... | 88 | 3.00 | 2220 | 86 | 1.1 | 3980 | 88 | 1.3 |
| No. 4.... | 98 | 2.57 | 2720 | 92 | 2.6 | 4550 | 93 | 2.0 |
| No. 5.... | 102 | 2.67 | 2400 | 95 | 1.8 | 4590 | 105 | 1.6 |
| Avg. of 1, 2, 3, 4.. | 99 | ... | 2320 | 95 | ... | 4260 | 95 | ... |

[a] Per cent of strength of Ottawa sand mortar with same cement.

[b] $p = \frac{0.6745}{\bar{x}} \sqrt{\frac{\Sigma x^2}{n(n-1)}}\ (100)$, where $\bar{x}$ is average strength, $x$ is deviation from the average, and $n$ is number of tests, in this case 10.

[c] Cement No. 5 was blend of equal parts of cements Nos. 1, 2, 3, and 4.

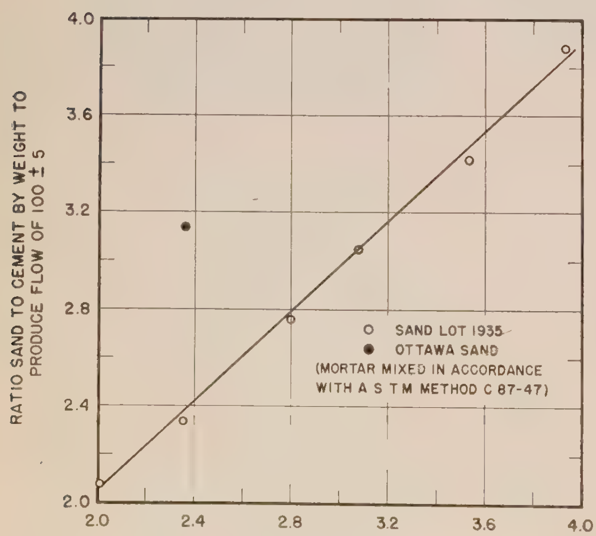


Fig. 2.—Relationship Between Fineness and Quantity of Sand in Plastic Mortar of Constant Flow (Series J-16).

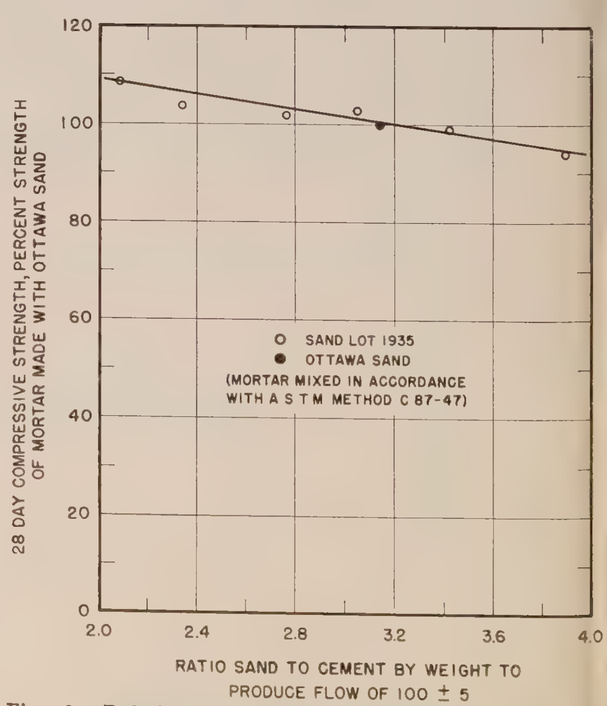


Fig. 3.—Relationship Between Quantity of Sand and Strength of Plastic Mortar (Series J-16).

# Creep Test Methods for Determining Cracking Sensitivity of Polyethylene Polymers*

By W. C. Ellis[1] and J. D. Cummings[1]

SYNOPSIS

Conventional creep testing methods for evaluating the cracking sensitivity of polyethylene polymers are described. The tests show that sensitivity to cracking in the presence of an active agent decreases with increasing average molecular weight of the polymer. For a given stress condition and environment, there appears to be a threshold value of stress and strain for the occurrence of cracking.

POLYETHYLENE polymers (of certain molecular weight range) when subjected to complex stressing in the presence of specific cracking agents, break with a brittle fracture (**1, 2, 3**).[2] The possibility of cracking must be taken into account in the application of the material, as in cable sheath. This paper describes a test for cracking sensitivity patterned after conventional creep test methods (**4, 5**) using strip-tension and pipe samples. Data obtained for pipe samples show that resistance to cracking increases with increase in average molecular weight of the polymer.

## MATERIALS INVESTIGATED

The polyethylene compounds used consisted of the polymers mixed with 1 or 2 per cent of fine particle size carbon black and a fractional per cent of antioxidant. The additions have been found to have no significant effect on resistance to cracking (**3**). The compounds were obtained from two manufacturers. For the strip-tension specimens the polymer had an average molecular weight corresponding to Williams plastometer numbers[3,4] of D52 to D55 at 130 C. Specimens were cut from compression molded sheets of nominal thickness of 0.125 in. The contour of the specimens was that shown in Fig. 2 of ASTM Standard Methods of Tension Testing of Metallic Materials (E8 – 46)[5] except that the gage length was increased to 3 in. The method of cross-milling, customarily used for preparing metal specimens, was unsatisfactory for the plastic. The transverse milling marks on the edges of the specimen introduced sufficient polyaxiality of stress under a tensile stress for uncontrolled cracking in the presence of surface-active agents. The edges of the specimens, for tests reported here, were finished by taking a light lengthwise cut with a wood chisel in conformity with the contour of a hardened steel jig.

Materials for the pipe specimens were polymers of three different and increasing average molecular weights with fine particle carbon black and antioxidant added. These average molecular weights were characterized by plasticity numbers: D52 to D56, D62 to D68, and D75 to D81.[6] The specimen (Fig.1) was a tube of polyethylene compound approximately 1½ ft in length obtained by removing the core of wires and the inner aluminum sheath from Alpeth cable (**7**) manufactured on a commercial machine. The pipe was about 2¾ in. in outside diameter and had a wall thickness of about 0.125 in. The inside surface was corrugated circumferentially to a small and irregular depth from contact with the inner aluminum sheath.

## METHODS OF TEST AND TEST RESULTS

*Strip-Tension Tests:*

The strip-tension specimens were modified for the cracking sensitivity test by making a series of four equally spaced transverse razor slits across the entire width and within the gage length. The slits were 0.010 ± 0.001 in. deep. This was accomplished by securing the blade in a fixture, allowing for extension of the blade by 0.010 in., and drawing the fixture across the face of the specimen. The transverse slits produced the polyaxiality of stress, a condition found early in our experience to be required for cracking (in exploratory studies specimens hung under constant stress without slits, or with longitudinal slits, showed no tendency to brittle failure when cracking agents were applied).

In carrying out the test, the edges and surfaces within the gage length of each specimen were treated with Igepal CA Extra, a wetting agent made by General Dyestuff Corp., and subjected at 80 F. to a series of stresses from 200 to 800 psi. The stresses were calculated from the initial cross-section, neglecting the slits. Igepal CA Extra provides a powerful cracking environment, remains rela-

Fig. 1.—Pipe Specimen.

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* Presented at the Fifty-fourth Annual Meeting of the Society, June 18 to 22, 1951.

[1] Member of Technical Staff, Bell Telephone Laboratories, New York, N. Y.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

[3] Tentative Method of Test for Plasticity and Recovery of Rubber and Rubber-Like Materials by the Parallel Plate Plastometer (D 926 – 47 T), 1949 Book of ASTM Standards, Part 6, p. 1156.

[4] Williams plasticity numbers increase with the molecular weights of the polymers as determined by the Staudinger solution viscosity method (**6**).

[5] 1949 Book of ASTM Standards, Part 1, p. 1233.

[6] If the Staudinger method is applied, the corresponding average molecular weights (**3**) are: 22,000, 24,000, and 27,500.

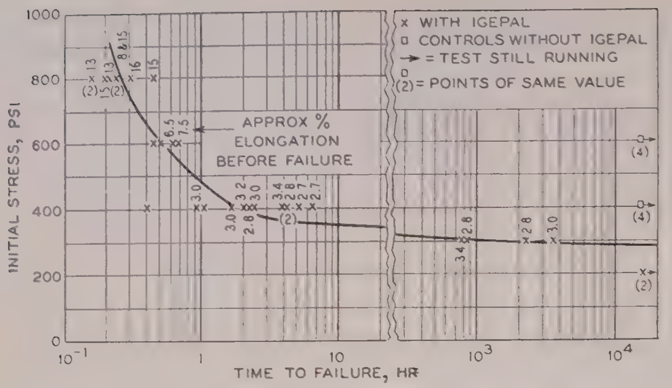



**Fig. 2.—Cracking Resistance of D52–55 Polyethylene Compound Using Strip-Tension Specimens with Slits.**

Environment is Igepal CA Extra at 80 F.

tively stable, does not evaporate over the period of the test, and is representative in action to a large number of cracking agents (3). Specimens without the cracking agents were stressed at the same time for comparison of fracture times. Faint lines were scribed on the specimens to provide the bench marks for measuring strain.

The results of this study are shown in Fig. 2 for a polymer of plasticity number D52–D55. The curve is essentially of a stress-rupture character as obtained for metals. The time-to-rupture of the treated specimens increased rapidly with decrease in initial stress; those specimens initially stressed at 200 psi did not fail in 16,000 hr when the test was discontinued. None of the specimens with slits, but without cracking environment, failed in 16,000 hr.

The figures associated with the curve at the several stress levels are the approximate longitudinal strains shortly before failure. The values for the longitudinal tensile stress just before failure are increased from the initial values by the strain which the specimen has undergone. The buildup of strain with time was, in general, that observed in standard creep tests (4).

The method is a critical one for determining cracking sensitivity in sheet polymers. It has the advantages of using conventional creep-testing facilities and specimens readily available in an experimental program. The method has the disadvantage of being empirical in that no number can be readily assigned to the exact stress concentration or degree of polyaxiality introduced at a transverse slit.

The method differs, in important respects, from others reported for studying cracking sensitivity on strip specimens in the presence of environments. R. H. Carey (2) reports a method that is essentially a short-time tension test on a specimen with a hole drilled through the face of the gage length to introduce stress polyaxiality and with the specimen immersed in an appropriate fluid to provide the cracking environment. The index of brittleness is the stress and strain at failure compared to values for the usual tension test. DeCoste, Malm, and Wallder (3) have reported a rapid test in which a strip constrained to U-shape and containing a longitudinal controlled slit at the U-bend is immersed in a cracking fluid; time to failure is observed. Stress relaxation occurs in this test and the crack develops at right angles to the introduced slit. In the test described by the authors there is no stress relaxation and the crack follows the razor slit.

*Pipe Bursting Tests:*

The pipe specimens were fitted with brass end plugs, one containing a pressure gage, the other a valve for introducing air pressure as shown in Fig. 1. Before inflation, Igepal CA Extra was brushed on the outside of the pipes for the central three-fourths of the length. The pipes were inflated to a series of values of air pressure giving circumferential stresses from 400 to 1400 psi. These tests were also made at 80 F.

Strains were determined by taking readings at the midsection with a diameter tape initially and periodically after inflation. Rupture was taken as the time when the air pressure decreased abruptly. The ruptures were small longitudinal slits located usually by the bubbling of a detecting Igepal solution. The thickness of the pipe at the point of failure and the average expanded diameter were used in computing the stress at failure.

Polyaxiality of stress was achieved by the geometry of the specimen, since in a pipe sample with thin walls the circumferential stress is twice the longitudinal stress resulting in a biaxial ratio of 2. The small radial stress of compression can be neglected. Since the circumferential corrugations mentioned earlier were far from sharp notches, the polyaxiality of stress introduced by them is trivial in relation to that resulting from the geometry of the sample. With a biaxial stress ratio of 2 and with essentially plastic extension, the longitudinal strain is practically zero. The biaxial strain ratio is therefore very large. This was confirmed by the use of grids as described by Hopkins, Baker, and Howard (8).

The circumferential stress was calculated by the thin-walled tube formula:

$$\text{Stress (psi)} = \frac{pD}{2t}$$

where:

$p$ = air pressure, psi,
$D$ = average expanded diameter of tube, in., and
$t$ = thickness of tube wall, in.

Stresses so calculated are estimated to be correct within 10 per cent.

The results for the three polymers are shown in Fig. 3 by stress-rupture curves. The stresses recorded are those calculated for wall thickness at failure. Since there is considerable scatter in points, the curves are drawn to represent

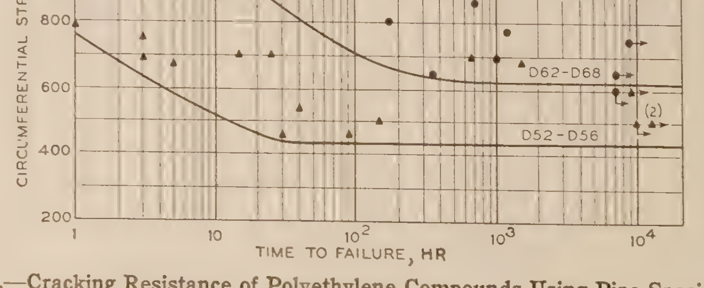



**Fig. 3.—Cracking Resistance of Polyethylene Compounds Using Pipe Specimens.**

Environment is Igepal CA Extra at 80 F.

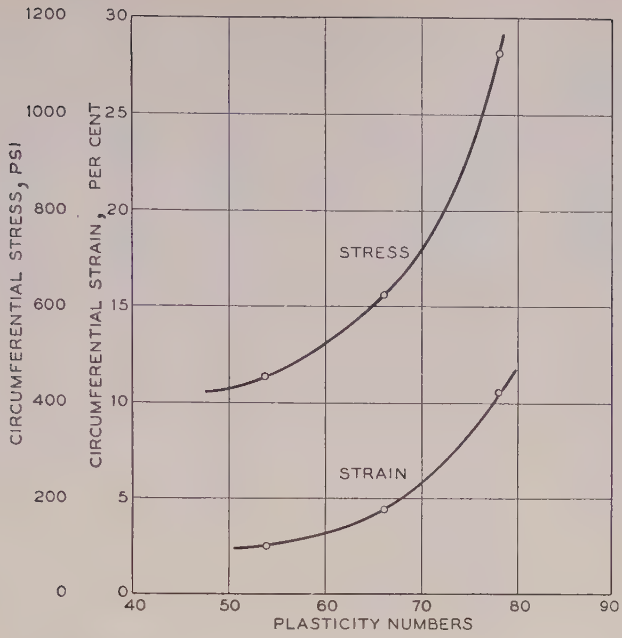



**Fig. 4.—Circumferential Stress and Associated Strain Below Which No Cracking Occurred in 10,000 hr.**

Related to the plasticity ranges of the polyethylene compounds. Biaxial stress ratio, 2:1; environment is Igepal CA Extra at 80 F.

the locus below which no failures were obtained. This seems to be a good method of representing the merit of the different polymers, although one would come to the same conclusions by drawing an average curve through the time of failure. None of the pipe samples at corresponding stresses without cracking agent failed in the period of the test. However, for the lowest plasticity range (D52 to D56) there were brittle failures without a cracking agent at stresses higher than those used with Igepal CA Extra applied. These failures would be expected from the work of Hopkins, Baker, and Howard (8) who rapidly stressed diaphragms by internal pressure (biaxial ratio of 1:1) and observed a large decrease in total strain and the occurrence of brittle failure for low average molecular weight polymers.

The circumferential stresses for which no failures occurred in 10,000 hr are given in Fig. 4 as a function of the plasticity numbers of the three polymers. The associated strains are also shown. These data are, as in the case of the strip-tension specimens, for the condition in which there is no stress relaxation. The cracking resistance to Igepal CA Extra increases with the average molecular weight range of the polymers in this series and rather steeply in progressing from the plasticity range D62–68 to D75–81. This is in qualitative agreement with the findings of DeCoste, Malm, and Wallder (3) using a different type of test.

From the data for the pipe samples, some observations can be made of the effect of the magnitude of stress and strain on the occurrence of cracking. The time for cracking increases very rapidly with decrease in value of stress and, therefore, with decrease in value of strain at fracture. The shapes of the curves, Fig. 3, suggest values of stress and corresponding ones of strain below which cracking will not occur, or at least will occur only after a very long elapsed time. Approximate values of the threshold stresses and strains for cracking, with a biaxial stress ratio of 2:1 and with the very active Igepal CA Extra as an environment can be taken from the curves of Fig. 4 for the three polymers.

## Summary


Two test methods for determining the cracking sensitivity of polyethylene polymers have been described: one utilizing strip-tension specimens is particularly applicable for appraisal of materials in an experimental program; the other using internal pressure in a pipe sample is applicable to polymers manufactured in the form of tubes.

The methods of stressing produce polyaxial or biaxial stress required for cracking to occur. In the pipe sample, no artificial notching is necessary and the biaxial stress can be calculated. Both tests are modifications of conventional creep test methods.

Polyethylene polymers of different plasticity numbers were rated as to crack resistance. Crack resistance increased with plasticity number and, therefore, with increase in average molecular weight range.



*Acknowledgment:*

The special grades of compounds were supplied by the Bakelite Co. and the duPont Co. The sheets of compound required were molded by G. F. Brown, Jr., at the Bell Telephone Laboratories. The pipe samples were obtained from cable made by the Western Electric Co.


## References


(1) R. B. Richards, "The Effect of Polymer Chain Length on the Solubility and Swelling of Polyethylene," *Transactions*, Faraday Soc., Vol. 42, p. 10 (1946).

(2) R. H. Carey, "Stress Cracking of Polyethylene," ASTM Bulletin, No. 167, July, 1950, p. 56.

(3) J. B. DeCoste, F. S. Malm, and V. T. Wallder, "Environmental Cracking of Stressed Polyethylene," *Industrial and Engineering Chemistry*, Vol. 43, p. 117 (1951).

(4) G. R. Gohn, J. D. Cummings, and W. C. Ellis, "The Creep Characteristics of Compression Molded Polyethylene," *Proceedings*, Am. Soc. Testing Mats., Vol. 49, p. 1139 (1949).

(5) H. S. Phelps, F. Kahn, and W. P. Magee, "Influence of Small Percentages of Silver on the Tensile Strength of Extruded Lead Sheathing," *Proceedings*, Am. Soc. Testing Mats., Vol. 48, p. 815 (1948).

(6) W. J. Clarke, "Properties of Different Polyethylenes," *Transactions*, Am. Inst. Electrical Engrs., Vol. 64, p. 919 (1945).

(7) R. P. Ashbaugh, "Alpeth Cable Sheath," *Bell Telephone Laboratories Record*, Vol. 26, November, 1948.

(8) I. L. Hopkins, W. O. Baker, and J. B. Howard, "Complex Stressing of Polyethylene," *Journal of Applied Physics*, Vol. 21, p. 206 (1950).

MR. JULES PINSKY.[1]—Has any analysis been made as to the effect of the low molecular weight fraction rather than the low average molecular weight?

MR. W. C. ELLIS (*author*).—No analysis was made in this study of the specific effects of the low molecular weight fractions in each of the grades of polyethylene. The paper was primarily concerned with the development of test methods. However, it appears that a high degree of crack resistance is obtained if the average chain length is sufficiently long, although composition variables, such as molecular weight distribution and chain branching, may play an important part. This is illustrated by the results for the three grades of polyethylene in this investigation.

[1] Physicist, Plax Corp., Hartford, Conn.

MR. M. W. BROSSMAN.[2]—Has any attempt been made to determine the effect of moisture on the crack formation? This sort of thing has been shown to be very important in crazing.

MR. ELLIS.—There was no attempt to control the humidity of the room in which the tests were made. Many surface-active agents contain water—for example soap solutions—but others do not, as some animal and mineral oils (**3**).*

MR. G. M. KLINE.[3]—What is the chemical nature of the surface-active agent?

MR. ELLIS.—The surface-active agent used in this work, Igepal CA extra, has been described as a complex glycol ether. The source, as identified in the paper, was General Dyestuff Corp.

* The boldface numbers in parentheses refer to the list of references appended to the paper, see p. 49 (TP243).

[2] Physicist, Naval Research Laboratory, Washington, D. C.

[3] Chief, Organic Plastics Section, National Bureau of Standards, Washington, D. C.

MR. C. E. PARKS.[4]—Are all these tests made at room temperature?

MR. ELLIS.—All tests reported in the paper were made at 80 F.

MR. PARKS.—Were tests made on the effects of varying temperature?

MR. ELLIS.—A few tests were made at a higher temperature of 140 F on pipe samples. A higher temperature accelerates the cracking effect. DeCoste, Malm, and Wallder (**3**) report an accelerating effect in their work in going from a temperature of 77 to 130 F.

[4] Manager, Development Lab., B. F. Goodrich Chemical Co., Avon Lake, Ohio.

# Cleaning of Steel Test Panels for Paint

By Thomas Rice[1]


SYNOPSIS

The findings of a special group[2] of ASTM Committee D-1 on Paint, Varnish, Lacquer and Related Products over a period of years has led to the most recent revision of Tentative Method D 609.[3] Among the more important results of the work are conclusions that panels should not be sanded or abraded, either partially or totally.

Two basic cleaning methods for removal of oil and smut have been adopted, that is, solvent spray cleaning and trichlorethylene vapor degreasing and also two modifications of these in which a phosphoric acid dip is used. Methods of dipping in solvent and then wiping with rags saturated with solvent have not been found reliable.

A standard method for packaging panels has been adopted following an investigation of several methods.

Methods for testing cleaned panels for cleanliness and surface activity have been investigated and recommendations are given. However, Method D 609 has not been amended to include these new methods. The adoption of cleanliness tests as standard procedures must await further experience and trial, and if found satisfactory, the necessary revisions of Method D 609 will be made.


AT A meeting of Subcommittee VII of ASTM Committee D-1, the question arose whether it was permissible to prepare or reclaim rusted panels by sanding or abrading, as certain U. S. Army departmental specifications permitted used panels for laboratory tests and the reclaiming of used panels by sanding. Also, there was considerable discussion relative to methods for cleaning panels. As a result, Group 1 on Preparation of Steel Test Panels was appointed to investigate the two problems.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Rock Island Arsenal, Rock Island, Ill.; Chairman, Group 1, Subcommittee VII, Committee D-1.

[2] Group 1 on Preparation of Steel Test Panels for Paints of Subcommittee VII on Accelerated Tests for Protective Coatings of Committee D-1.

[3] Tentative Method of Preparation of Steel Panels for Testing Paint, Varnish, Lacquer and Related Products (D 609 – 50 T), 1950 Supplement to Book of ASTM Standards, Part 4, p. 84.

The committee outlined the following program for investigation:

1. A comparison of naphtha dip (solvent wipe) cleaning with trichlorethylene vapor degreasing.
2. A comparison of sanded with unsanded panels.

For the study of both problems, water immersion, humidity, salt solution immersion, and salt spray tests were selected.

## COMPARISON OF SOLVENT CLEANING METHODS

Panels for comparing solvent cleaning methods were cleaned by (*a*) the solvent wipe procedure and (*b*) by trichlorethylene degreasing, after which the panels were dipped in 95 per cent ethyl alcohol, dried at 160 F for $\frac{1}{2}$ hr and cooled in a desiccator before painting. The protective coating consisted of one spray coat of synthetic, rust-inhibiting primer conforming to U. S. Army Specification AXS-750 (an alkyd resin, zinc chromate-iron oxide pigmented primer) followed by one spray coat of synthetic olive drab lusterless enamel, conforming to U. S. Army Specification AXS-752. The total film thickness of the two coats was 1.5 to 2.0 mils.

Experimental work showed that there were importat differences between panels cleaned by the solvent wipe procedure, and the trichlorethylene vapor degreasing. Panels cleaned by the solvent wipe procedure showed more variation in blister size when subjected to distilled water immersion (Fig. 1). However, rusting developed more rapidly and was less uniform on the panels cleaned by the trichlorethylene vapor degreasing method (Fig. 2).

In the 20 per cent salt water immersion test, the panels cleaned by the solvent wipe procedure were much slower to blister, and blistering was less uniform (Fig. 3).

The humidity and salt spray tests did not reveal any other differences between the panels cleaned by the two procedures.

The tests showed, therefore, that the solvent wipe procedure was not reliable

TABLE I.—RESULTS OF ACTIVITY TESTS ON PANELS CLEANED BY DIFFERENT METHODS.

| Procedure | Panel | Water Break | Alcohol Wash | Seconds for Corrosion | | | |
|---|---|---|---|---|---|---|---|
| | | | | Min | Max | Avg | Difference |
| 1. Hand sanding and naphtha cleaning (one dip) | No. 11 | None | Yes | 20 | 49 | 31 | 29 |
| | No. 12 | | | 25 | 40 | 33 | 15 |
| | No. 13 | | | 30 | 45 | 37 | 15 |
| | No. 14 | | | 25 | 50 | 40 | 25 |
| Summary | | | | 25 | 45 | (35)[a] | (20)[b] |
| | No. 15 | ... | No | 30 | 75 | 47 | 45 |
| | No. 16 | | | 35 | 60 | 51 | 25 |
| | No. 17 | | | 28 | 50 | 37 | 22 |
| Summary | | | | 30 | 55 | (45) | (30) |
| 2. Trichlorethylene vapor cleaning only (10 sec) | No. 21 | None | Yes | 25 | 55 | 40 | 30 |
| | No. 22 | | | 25 | 60 | 35 | 35 |
| | No. 23 | | | 20 | 70 | 48 | 50 |
| | No. 24 | | | 25 | 90 | 48 | 65 |
| Summary | | | | 25 | 65 | (45) | (40) |
| | No. 25 | ... | No | 70 | 110 | 100 | 40 |
| | No. 26 | | | 50 | 165 | 101 | 115 |
| | No. 27 | | | 30 | 110 | 79 | 80 |
| Summary | | | | 50 | 130 | (95) | (80) |
| 3. Solvent naphtha cleaning only (one dip plus two rinses) | No. 31 | Very bad | Yes | 30 | 70 | 42 | 40 |
| | No. 32 | | | 25 | 70 | 43 | 45 |
| | No. 33 | | | 30 | 55 | 42 | 25 |
| | No. 34 | | | 21 | 70 | 37 | 60 |
| Summary | | | | 25 | 65 | (40) | (40) |
| | No. 35 | ... | No | 30 | 70 | 47 | 40 |
| | No. 36 | | | 25 | 55 | 36 | 30 |
| | No. 37 | | | 25 | 45 | 35 | 20 |
| Summary | | | | 25 | 55 | (40) | (30) |
| 4. Mechanical sanding and naphtha cleaning | No. 41 | Very bad | Yes | 20 | 30 | 23 | 10 |
| | No. 42 | | | 25 | 40 | 31 | 15 |
| | No. 43 | | | 30 | 50 | 40 | 20 |
| | No. 44 | | | 28 | 50 | 43 | 20 |
| Summary | | | | 25 | 40 | (35) | (15) |
| | No. 45 | ... | No | 40 | 55 | 46 | 15 |
| | No. 46 | | | 25 | 45 | 35 | 20 |
| | No. 47 | | | 20 | 35 | 28 | 15 |
| Summary | | | | 30 | 45 | (35) | (15) |
| 5. Mechanical sanding only | No. 51 | None | Yes | 20 | 70 | 46 | 50 |
| | No. 52 | | | 30 | 70 | 59 | 40 |
| | No. 53 | | | 25 | 60 | 43 | 35 |
| | No. 54 | | | 30 | 70 | 45 | 40 |
| Summary | | | | 25 | 70 | (45)[a] | (40)[b] |
| | No. 55 | ... | No | 110 | 110 | 110 | 0 |
| | No. 56 | | | 100 | 100 | 100 | 0 |
| | No. 57 | | | 80 | 80 | 80 | 0 |
| Summary | | | | 95 | 95 | (95) | (0) |
| 6. Pickled in ferric sulfate solution | No. 61 | None | Yes | 35 | 50 | 42 | 15 |
| | No. 62 | | | 32 | 40 | 36 | 10 |
| | No. 63 | | | 30 | 40 | 35 | 10 |
| | No. 64 | | | 30 | 40 | 33 | 10 |
| Summary | | | | 30 | 40 | (35) | (10) |
| | No. 65 | ... | No | 35 | 35 | 35 | 0 |
| | No. 66 | | | 28 | 35 | 33 | 5 |
| | No. 67 | | | 25 | 35 | 33 | 10 |
| Summary | | | | 30 | 35 | (35) | (5) |
| 7. Spray naphtha cleaning | No. 71 | Slight (only along edges) | Yes | 25 | 55 | 36 | 30 |
| | No. 72 | | | 25 | 35 | 30 | 30 |
| | No. 73 | | | 20 | 55 | 33 | 35 |
| | No. 74 | | | 22 | 40 | 30 | 20 |
| Summary | | | | 25 | 45 | (30) | (30) |
| | No. 75 | ... | No | 30 | 60 | 42 | 30 |
| | No. 76 | | | 20 | 40 | 33 | 20 |
| | No. 77 | | | 20 | 40 | 30 | 20 |
| Summary | | | | 25 | 45 | (35) | (25) |
| 8. Sanding, degreasing and alkaline electrocleaning | No. 81 | None | Yes | 21 | 21 | 21 | 0 |
| | No. 82 | | | 13 | 20 | 18 | 7 |
| | No. 83 | | | 16 | 17 | 17 | 1 |
| | No. 84 | | | 15 | 18 | 17 | 3 |
| Summary | | | | 15 | 20 | (20) | (3) |
| | No. 85 | ... | No | 20 | 20 | 20 | 0 |
| | No. 86 | | | 17 | 20 | 20 | 3 |
| | No. 87 | | | 15 | 17 | 17 | 2 |
| Summary | | | | 20 | 20 | (20) | (2) |
| 9. Degreasing and alkaline electrocleaning | No. 95 | None | No | 20 | 25 | 23 | 5 |
| | No. 96 | | | 15 | 20 | 18 | 5 |
| | No. 97 | | | 15 | 20 | 18 | 5 |
| Summary | | | | 15 | 20 | (20) | (5) |

[a] High value should indicate low surface activity. [b] High value should indicate low surface uniformity.

as a cleaning procedure. Moreover, there was not sufficient evidence of the superiority of trichlorethylene vapor degreasing to warrant adoption of it to replace other cleaning procedures.

### Sanded *Versus* Unsanded Panels

Panels prepared for comparison of sanded *versus* unsanded surfaces were solvent cleaned (dipped and scrubbed in naphtha) to remove excess oil and then the lower half of each panel was totally sanded and the upper half spot sanded on five diamond-shaped areas, $\frac{1}{2}$ in. square. The partially sanded panels were then cleaned by the solvent wipe procedure, painted as outlined above, and subjected to the four tests.

In water immersion tests, blisters developed more rapidly on unsanded areas than on sanded, but the chief difference was in the size of blisters. Blisters were larger on the unsanded areas, and conversely rusting was greater on sanded areas. The same effects were produced on panels subjected to the 20 per cent salt water immersion test. Figures 4, 5, and 6 show the above differences in blister size and increased rusting on the sanded areas of the panels, that is, lower halves and five diamond-shaped areas in the upper halves. Additional proof of the accelerating effect on the increased rusting caused by sanding is shown in Fig. 7 showing panels (stripped) after six days in 20 per cent salt spray.

### Tests on Rust Preventive Treatment and Packaging of Panels

A committee was appointed to investigate the subject of packaging of test panels to insure that Method D 609 test panels would be delivered to the consumer in satisfactory condition and remain rust free until used. A program for testing packaged panels was prepared.

The first tests were made on a series of six packages of 20 panels each with several commercial rust preventives and paper wrappings as follows:

1. Mill oiled. Coated oil retarding inner wrapper. Neutral pH ordnance bag for outside wrapper.
2. Dipped in Aromatic No. 50440 Oil. Wrapper same as No. 1.
3. Dipped in No. 7 Anti-Rust Oil. Wrapper same as No. 1.
4. Dipped in Finoil. Wrapper same as No. 1.
5. Mill oiled. Ordinary Kraft paper wrapper.
6. Dipped in No. 7 Anti-Rust Oil. Ordinary Kraft paper wrapper.

Conditions for storage for 30 days were described as follows:

Test No. 1—Alternate high (100 F, 85 per cent relative humidity) and low temperature (20 F).

Test No. 2—Vapor fumes (1 per cent

acetic acid at 80 F and 85 per cent relative humidity).

Test No. 3—High humidity (100 per cent relative humidity at 85 F).

Test No. 4—Ordinary room conditions.

The results of the 30-day tests can be summarized as follows:

Test No. 1—Package No. 3 was found to be outstanding.

Test No. 2—Package No. 3 rated best, but panels in all packages were etched

Test No. 3—Panels in packages Nos. 2, 3, and 1 were rated least rusted. Panels in packages Nos. 3 and 6 had a peculiar darkened or etched appearance.

Test No. 4—Packages Nos. 1 and 3 were rated least rusted, but panels in package No. 3 had darkened or etched appearance not quite as severe as in test No. 3.

The tests so far showed that the ordnance bag packaging and the rust preventive applied at the mill gave protection equal to or superior to any of the packaging procedures tried. However, the use of any rust preventive other than that applied at the mill would be impractical if not impossible. For the small tonnage of sheet steel involved, the rolling mills could not apply economically a rust preventive different from that used in production. The rust preventive in use at the mill was light petroleum oil and Ferrocote No. 351 additive.

A second series of tests was conducted

TABLE II.—PANEL PREPARATION, WATER-BREAK TESTS AND ACTIVITY RATING AVERAGES.

| Panel Preparation | Water-Break Test | | Modified Mears Activity Tests | | | |
|---|---|---|---|---|---|---|
| | Initial, per cent | Final, per cent | Average Maximum, sec | Average Minimum, sec | Over-all Average, sec | Difference, Average Maximum-Minimum |
| Solvent Wipe, VM and P Naphtha + Cellosolve | 12 to 19 | 82 to 78 | 36 | 15 | 24.5 | 21 |
| Solvent Wipe and Bake, VM and P Naphtha + Cellosolve | 34 to 30 | 39 to 54 | 29 | 10 | 20.7 | 19 |
| Solvent Wipe, VM and P Naphtha + Xylene | 47 to 68 | 82 to 83 | 35 | 11 | 23.5 | 24 |
| Solvent Wipe and Bake, VM and P Naphtha + Xylene | 45 to 00 | 80 to 86 | 28 | 12 | 19.4 | 16 |
| Solvent Spray, VM and P Naphtha + Cellosolve | 99 to 98 | 98 to 97 | 21 | 12 | 15.5 | 9 |
| Solvent Spray and Bake, VM and P Naphtha + Cellosolve | 100 to 98 | 98 to 98 | 27 | 12 | 18.2 | 15 |
| Solvent Spray, VM and P Naphtha + xylene | 100 to 99 | 98 to 98 | 18 | 10 | 13.6 | 8 |
| Solvent Spray and Bake, VM and P Naphtha + Xylene | 100 to 100 | 62 to 82 | 29 | 16 | 23.0 | 13 |
| Trichlorethylene Degrease | 100 to 100 | 100 to 100 | 48 | 17 | 26.4 | 31 |
| Trichlorethylene Degrease and Bake | 100 to 100 | 98 to 100 | 39 | 14 | 23.9 | 25 |

Solvent wipe.

Trichlorethylene vapor degreased.

**Fig. 1.—Distilled Water Immersion, 1700 hr.**

for the purpose of testing the rust preventive to be used by the rolling mill and the packaging to be employed. The same tests were used as above, except that Test No. 5 was to be conducted at 108 F, 100 per cent relative humidity, with only two packaging procedures. These consisted of the Kraft paper wrapping contained in the ordnance bag as Set No. 1, and in a heat-sealed, foil-lined paper bag or envelope as Set No. 2. All investigations reported no rusting on Set No. 2, and in general, some rusting on panels of Set No. 1 in the 30-day test.

As a result of these tests, the committee recommended that the panels should be wrapped in Kraft paper and enclosed in a heat-sealed, foil-lined envelope. The rust preventive to be used was specified as one part of Ferrocote No. 351 in nine parts of petroleum oil.

TABLE III.—TESTS ON CLEANED AND SOILED PANELS.

| Soil, ml Oil per 100 sq cm | Numbers of Panels Tested | Activity Test | | Drop Test | | Contact Angle | |
|---|---|---|---|---|---|---|---|
| | | Tests per Panel | sec | Tests per Panel | Diameter, mm | Tests per Panel | deg |
| **Cleaned by Procedure A—Solvent Spray Cleaning** | | | | | | | |
| None | 4 | 5 | 17 | 3 | 20 | 5 | 44 |
| (1 ml naphtha) | 3 | 5 | 13 | 3 | 20 | 5 | 46 |
| 0.00005 | 3 | 5 | 13 | 3 | 18 | 5 | 62 |
| 0.0001 | 3 | 5 | 14 | 3 | 14 | 5 | 65 |
| 0.00025 | 3 | 5 | 16 | 3 | 10 | 5 | 63 |
| 0.0005 | 3 | 5 | 13 | 3 | 10 | 5 | 63 |
| **Cleaned by Procedure B—Solvent Spray and Phosphoric Acid** | | | | | | | |
| None | 5 | 5 | 31 | 3 | 20 | 5 | 49 |
| (1 ml naphtha) | 3 | 5 | 27 | 3 | 21 | 5 | 42 |
| 0.00005 | 3 | 5 | 32 | 3 | 17 | 5 | 54 |
| 0.0001 | 3 | 5 | 32 | 3 | 17[a] | 5 | 57 |
| 0.00025 | 3 | 5 | 11 | 3 | 16[a] | 5 | 77 |
| 0.0005 | 3 | 5 | 11 | 3 | 17[a] | 5 | 78 |

[a] Splattered effect and nonwetted pinholes.

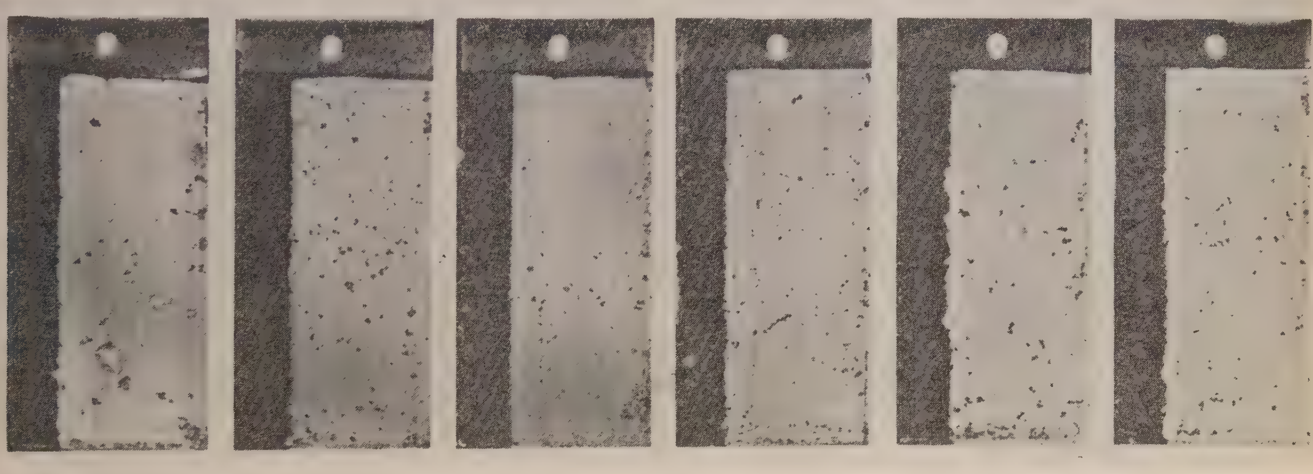
### Cleanliness of Panel Surfaces

It is difficult to prescribe methods for cleaning panels without having a standard available for a clean and uniform surface. Work was undertaken to evaluate methods for testing the cleanliness of metal surfaces to determine which was most suitable for such purposes.

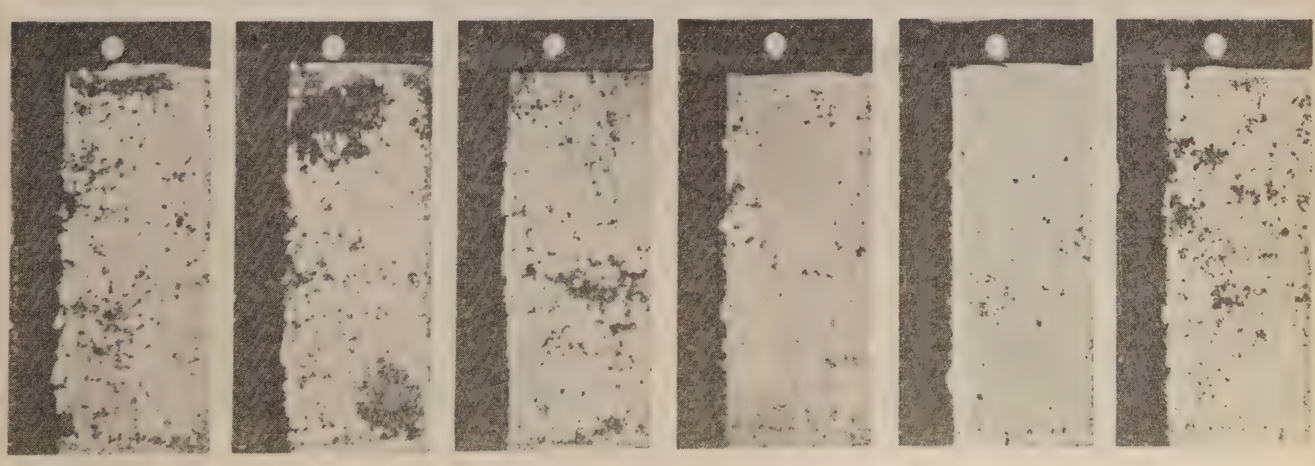
Elm's modification of the Mears[4] activity test was used in some tests reported at a meeting of Subcommittee VII[5] by H. A. Nelson of the New Jersey Zinc Co. This modification used a solution of 32 ml of hydroxyl (30 per cent $H_2O_2$) in 1 liter of distilled water. Single drops of this solution were placed on the selected areas by means of a medicine dropper and the time required for first appearance of corrosion spots was noted. Accurate detection of these spots requires proper adjustment of the illumination, which can best be worked

[4] R. B. Mears and U. R. Evans, "The Probability of Corrosion," *Transactions, Faraday Society*, Vol. 31, Part 1, p. 257 (1935).

[5] H. A. Nelson, Test for Uniformity of Surface of Cleaned Steel Panels and Relative Effectiveness of Different Cleaning Methods. Unpublished report, New Jersey Zinc Co., Palmerton, Pa. (1946).



Solvent wipe.



Trichlorethylene vapor degreased.

Fig. 2.—Distilled Water Immersion, Stripped After 1700 hr.

out by preliminary tests. Twelve drops were distributed on the surface of each panel ($2\frac{3}{4}$ by $5\frac{7}{8}$ in.)

The results of these tests are shown in Table I. The column headed "Water Break" refers to the test which has been in general use for many years in which the panel is immersed in distilled water and after withdrawal it is noted whether the surface remains wet or shows nonwetted areas or "water break." A surface showing no "water break" has been generally accepted as a clean surface. The last four columns show the results of the modified Mears test described above. Differences in the activity of surfaces cleaned by the nine procedures are apparent with Procedures 8 and 9 showing the lowest readings (most active) and the lowest differences in readings.

Since Procedures 1, 4, 5, and 8 employed sanding, none of these procedures could be considered as standards in view of the previous work on sanded surfaces. With the exception of surfaces cleaned by Procedures 8 and 9, Procedure 7 gave the lowest activity readings but not the best uniformity.

TABLE IV.—RESULTS OF WATER-BREAK TESTS BY DIPPING IN DISTILLED WATER.[a]

| Panels Treated with 0.5 Per Cent Oil | | Panels Treated with 0.1 Per Cent Oil | | Panels Treated with 0.01 Per Cent Oil | | Panels Cleaned, Not Oiled | |
|---|---|---|---|---|---|---|---|
| Per Cent WBF | Dev. from Mean | Per Cent WBF | Dev. from Mean | Per Cent WBF | Dev. from Mean | Per Cent WBF | Dev. from Mean |
| 28 | 3 | 85 | 34 | 97 | 1 | 100 | 0 |
| 30 | 1 | 47 | 4 | 96 | 2 | 100 | 0 |
| 14 | 17 | 10 | 41 | 98 | 0 | 100 | 0 |
| 17 | 14 | 76 | 25 | 99 | 1 | 100 | 0 |
| 32 | 1 | 23 | 28 | 97 | 1 | | |
| 29 | 2 | 15 | 36 | 99 | 1 | | |
| 13 | 18 | 96 | 45 | 100 | 2 | | |
| 10 | 21 | 25 | 26 | 99 | 1 | | |
| 37 | 6 | 89 | 38 | 97 | 1 | | |
| 54 | 23 | 94 | 43 | 99 | 1 | | |
| 51 | 20 | 38 | 13 | 96 | 2 | | |
| 48 | 17 | 21 | 30 | 93 | 5 | | |
| 42 | 17 | 61 | 10 | 95 | 3 | | |
| 34 | 3 | 20 | 31 | 98 | 0 | | |
| 48 | 17 | 30 | 21 | 97 | 1 | | |
| 37 | 6 | 93 | 42 | 100 | 2 | | |
| 23 | 8 | 17 | 34 | 100 | 2 | | |
| 15 | 16 | 85 | 34 | 96 | 2 | | |
| | | | | 95 | 3 | | |
| | | | | 100 | 2 | | |
| Mean = 31<br>S.D. = 14 | | Mean = 51<br>S.D. = 32 | | Mean = 98<br>S.D. = 2.04 | | Mean = 100<br>S.D. = 0 | |

[a] WBF = water-break-free.

where:

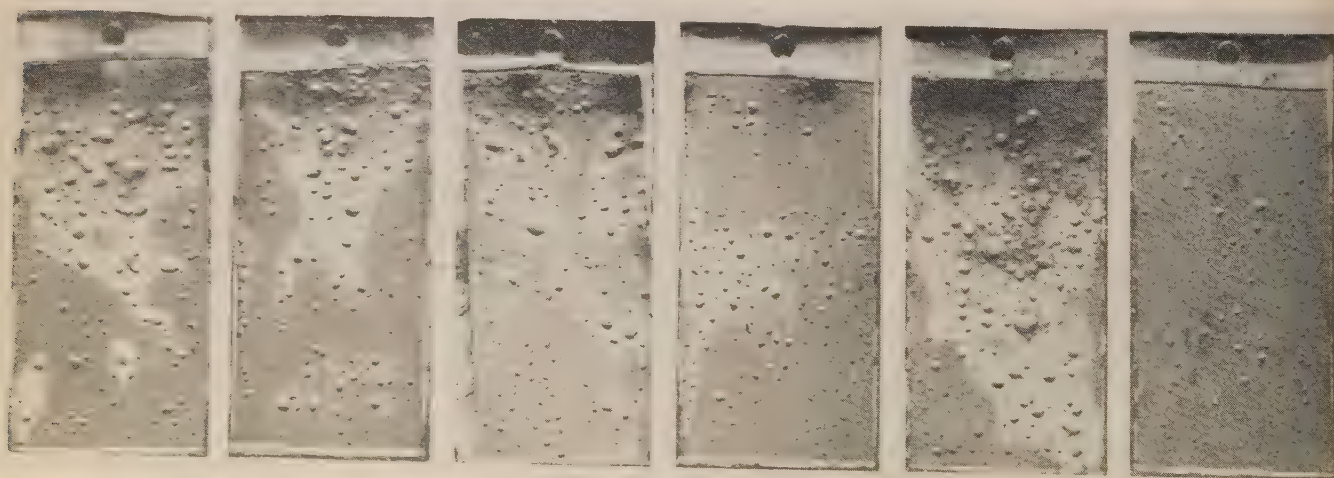
$$S.D. = \sqrt{\frac{\Sigma d^2}{n-1}}$$

$d$ = deviation from mean and $n$ = number of observations.

Tests of a similar nature were made[6] using a 2 per cent $H_2O_2$ solution containing 0.008 per cent NaCl. As shown in Table II, "Water-Break Test and Activity Rating Averages," this modification of the Mears test gave lower readings than that reported by H. A. Nelson. The most active and uniform

[6] Reported by M. Van Loo.

Solvent wipe.



Trichlorethylene vapor degreased.

Fig. 3.—20 per cent Salt Solution Immersion, 1700 hr.

surfaces were obtained on the panels cleaned by the solvent spray method.

Tests on cleaned and soiled panels were also made by another group which volunteered to conduct tests for the purpose of comparing various methods of testing surfaces for cleanliness. Panels which had been cleaned and then dipped in naphtha solutions containing 0.01, 0.1, and 0.5 per cent oil by volume and dried horizontally in order to leave an oil film on the surface were tested by both modifications of the Mears test. Activity tests did not detect differences between clean unsoiled panels and the soiled panels. On panels cleaned and treated with phosphoric acid in accordance with Method B of D 609 - 50 T activity tests were appreciably higher as shown in Table III.[7]

It appears, therefore, that the activity tests cannot be used as standard tests for measuring the cleanliness of steel panels but might be useful in judging the effect of phosphoric acid.

The best known test is the dip test or immersion in distilled water, in which the panel is immersed in distilled water and quickly withdrawn for examination for nonwetted areas known as water breaks. Clean panels should show 100 per cent wetted areas or zero per cent water break. Panels soiled by the 0.01 per cent oil solution could not be distinguished readily from clean panels as shown in Table IV.

Another modification of the water-break test is the spray water-break test.[8] Although one favorable report on its application was received, the consensus was that it was more difficult to perform than the dip test and probably offered no advantages.

The method of Morgan and Lankler based upon fluorescence of oils under ultraviolet light[9] was also investigated but was not found to be sensitive to the 0.1 per cent soiled panels.

The Rock Island Arsenal drop test[10] was also investigated and comparisons made with the preceding tests. In this test a 10-ml buret is placed 12 in. above the test panel. A drop of distilled water (approximately 0.05 ml volume) is

TABLE V.—FREQUENCY DISTRIBUTION OF VARIATION IN "WET" SPOT SIZE FOR FALLING DROP TEST.

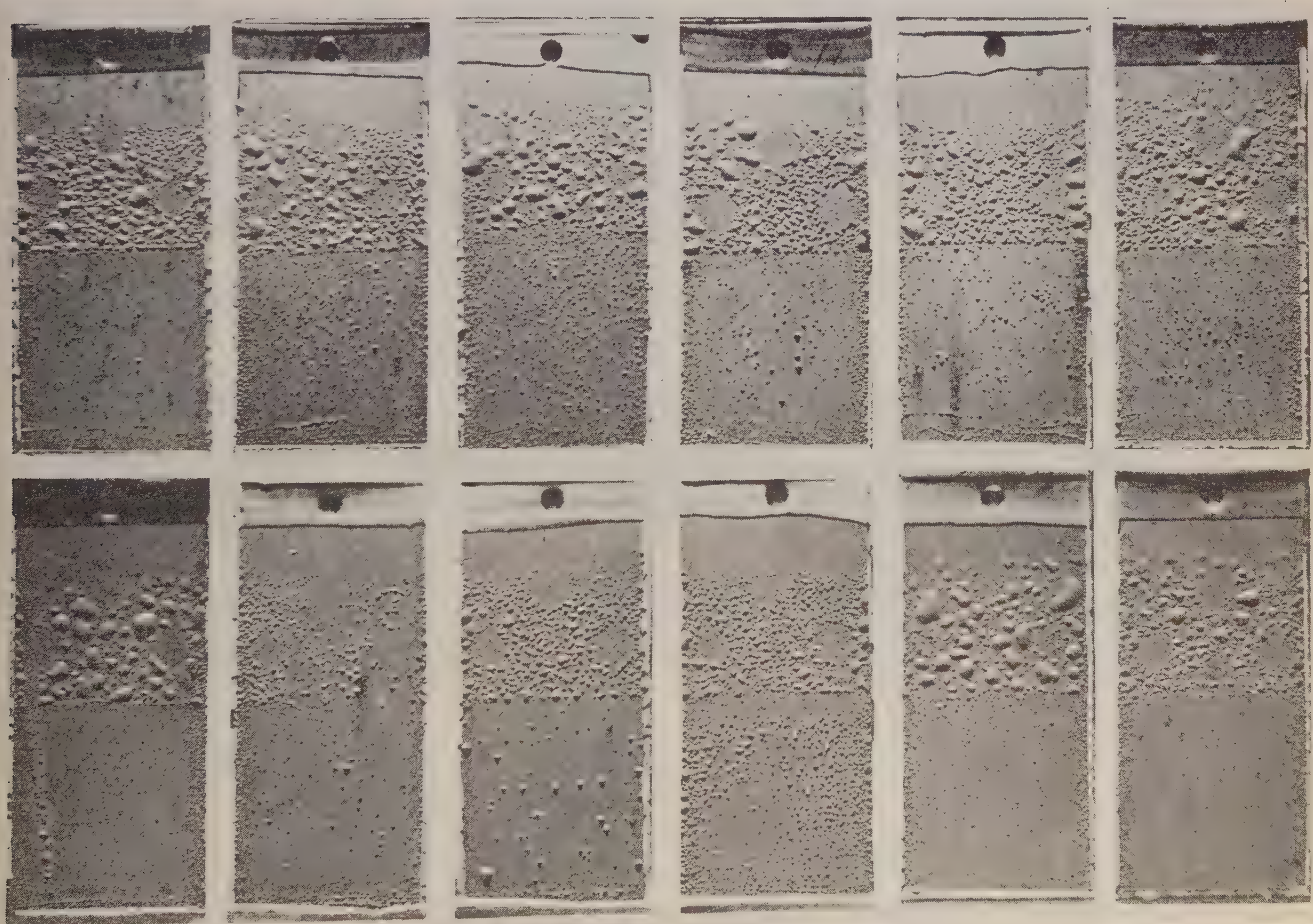
| Panels Treated with 0.5 Per Cent Oil | | Panels Treated with 0.1 Per Cent Oil | | Panels Treated with 0.01 Per Cent Oil | | Panels Cleaned, Not Oiled | |
|---|---|---|---|---|---|---|---|
| Size of Spot, in. | Times Occurring | Size of Spot, in. | Times Occurring | Size of Spot, in. | Times Occurring | Size of Spot, in. | Times Occurring |
| 0.438 | 13 | 0.438 | 5 | 0.563 | 4 | 0.688 | 2 |
| 0.500 | 40 | 0.500 | 16 | 0.625 | 22 | 0.750 | 4 |
| 0.563 | 30 | 0.563 | 34 | 0.688 | 44 | 0.813 | 33 |
| 0.625 | 7 | 0.625 | 42 | 0.750 | 35 | 0.875 | 1 |
| | | 0.688 | 13 | 0.813 | 5 | | |
| Total panels..........9 | | Total panels..........11 | | Total panels..........11 | | Total panels ..........4 | |
| Observations..........90 | | Observations..........110 | | Observations..........110 | | Observations..........40 | |
| Mean size.....0.500 in. | | Mean size......0.563 in. | | Mean size......0.688 in. | | Mean size......0.813 in. | |
| S.D..........0.053 in. | | S.D..........0.068 in. | | S.D..........0.064 in. | | S.D..........0.036 in. | |
| | | | | | | (0.688-in. results discarded) | |

[7] Thomas Rice, *Laboratory Report 49-1490*, Rock Island Arsenal (1949).

[8] S. Spring, H. I. Forman, and L. F. Peale, *Industrial and Engineering Chemistry, Anal. Ed.*, Vol. 18, No. 3, p. 201, March, 1946.

[9] O. M. Morgan and J. G. Lankler, *Industrial and Engineering Chemistry*, Vol. 34, p. 1158, October, 1942.

[10] V. Hong, "Determination of Specimen Surface Cleanliness by Use of a Falling Drop Method," *Laboratory Report 48-68*, Rock Island Arsenal (1948).



Solvent wipe. Diamond abraded upper half, solidly abraded lower half.

Fig. 4.—Distilled Water Immersion, 1700 hr.

dropped on the panel and its diameter measured. On clean panels the drop flattens out in an almost perfect circle with a scalloped edge, but on slightly oily surfaces the drops are smaller in diameter, usually without the scalloped edge. On very oily surfaces the drops are not round. Diameters may be measured in inches or millimeters, although the latter is preferable. As shown in Table V,[11] the test appears to be capable of distinguishing between the 0.01 per cent oil surface and the clean surface not oiled. Further evidence of the reliability of the drop test is shown in Table III.

The contact angle test was proposed[12] as another method for testing steel test panels for cleanliness. Panels cleaned in accordance with the recent revision of D 609 by the solvent spray method were soiled by dipping in naphtha solvent containing 0.5, 0.1, 0.01, and 0.005 per cent SAE 20 oil.

Results indicated that the contact angle method might detect oil on panels soiled with the 0.01 per cent oil solution and would definitely detect oil on panels soiled with the 0.1 per cent oil solution as shown by the following readings:

| Degree of Soil | Average Contact Angle, deg |
|---|---|
| Clean | 61 |
| 0.005 | 63 |
| 0.01 | 66 |
| 0.1 | 74 |
| 0.5 | 78 |

The contact angle apparatus described by I. Langmuir and V. J. Shaeffer[13] was modified as shown in Figs. 8 and 9. With this apparatus, the contact angle or angle of incidence between a panel surface and a drop of water can be determined by measuring the angle of a beam of light reflected from the drop.

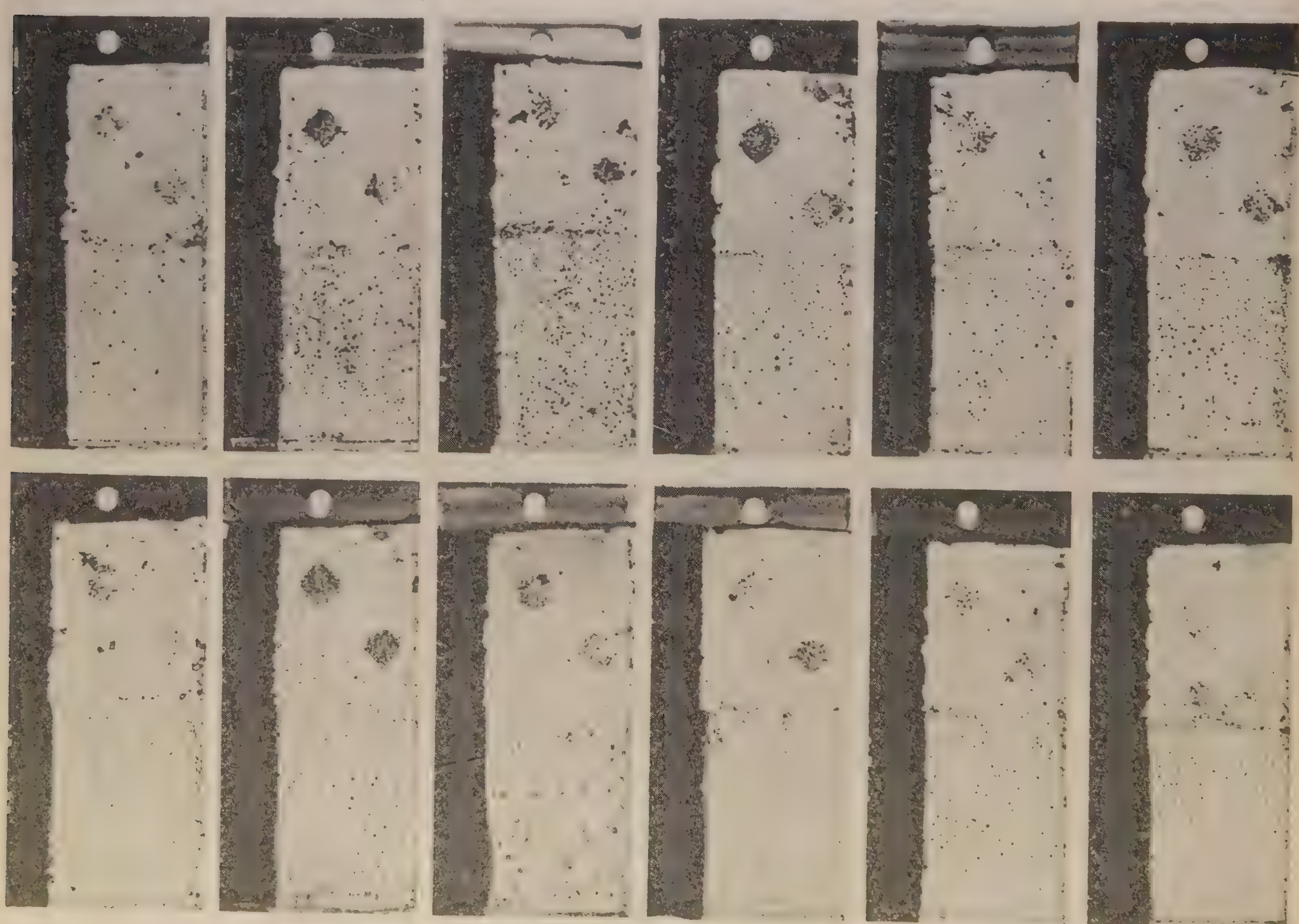
Referring to Figs. 8 and 9, it is seen that the contact angle apparatus consists essentially of a base *P*, a protractor *E*, a flashlight *B* mounted on a pivoted right-angle strip *C*, and a hypodermic syringe and needle *K*. The syringe *K* is held in position by the clamps *H* and *J* extending from post *G*. A utility clamp may also be used to hold the lower part of the syringe as shown in Fig. 9. The needle of the syringe *K* must be parallel to a line drawn vertical through the 90-deg graduation of the protractor *E*, and also midway between the peephole *H* and center of the flashlight *G*. The clearance cut *L* in the horizontal arm of strip *C* permits *C* to be pivoted to the 90-deg position without interference by the syringe *K*.

Exact dimensions are not essential, except the location of the needle as stated. The right-angle strip *C* can be made of 16-gage aluminum approximately 1 in. wide with a $3\frac{1}{2}$-in. vertical part with window *D* for reading the protractor and a horizontal part with a $\frac{1}{32}$-in. diameter peephole *A* located about $4\frac{1}{2}$ in. from the vertical part. The center of the flashlight *B* is located $2\frac{1}{2}$ in. from the vertical part and passes through a hole cut in the horizontal part of the right-angle strip *C*, 2 in. from the peephole *A*.

[11] Donald Price, Robt. F. Ayres, and James F. Young, Determination of the Relative Effectiveness of Cleanliness Tests for ASTM D 906 – 46 T Panels.

[12] M. Van Loo, Memorandum Report on the Determination of the Relative Effectiveness of Cleanliness Tests, June, 1948.

[13] I. Langmuir and V. J. Shaeffer, "Apparatus for Measuring Contact Angle," *Journal*, Am. Chemical Soc., Vol. 59, p. 2405 (1937).



Solvent wipe. Diamond abraded upper half, solidly abraded lower half.

Fig. 5.—Distilled Water Immersion, Stripped After 1700 hr.

Solvent wipe. Diamond abraded upper half, solidly abraded lower half.

**Fig. 6.—20 per cent Salt Solution Immersion, 1700 hr.**

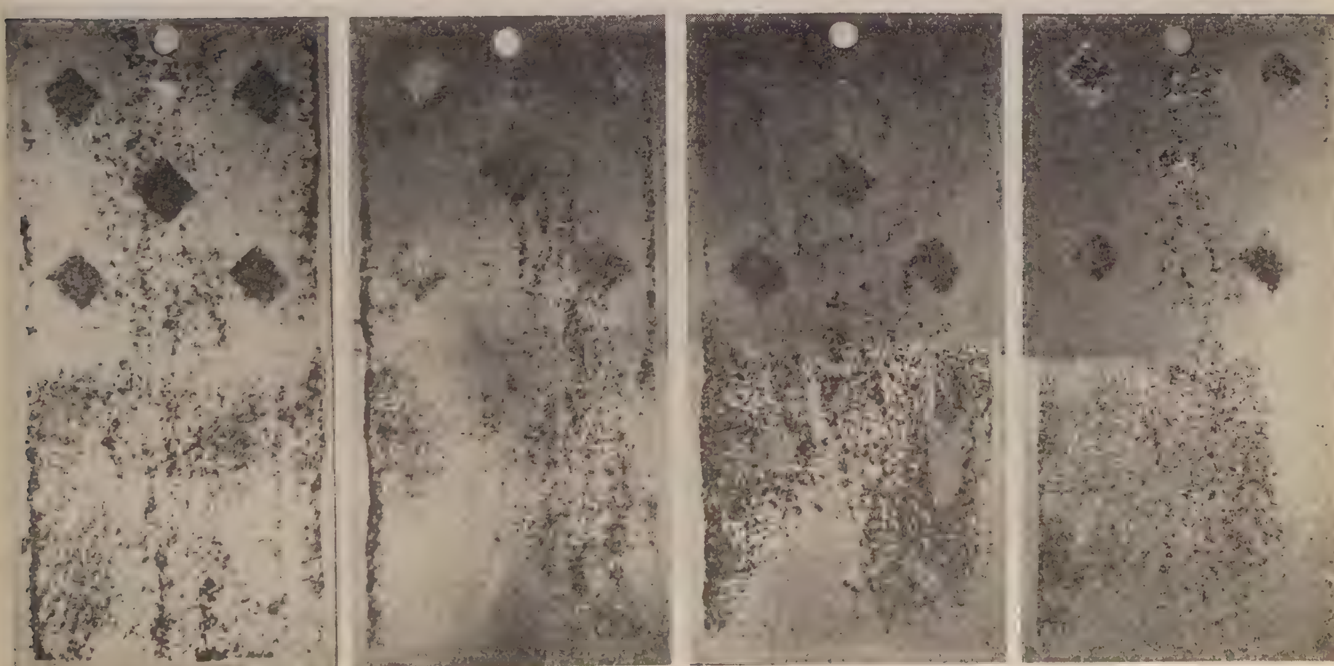


Fig. 7.—Sanded Panels After 6 Days in Salt Spray, After Stripping.

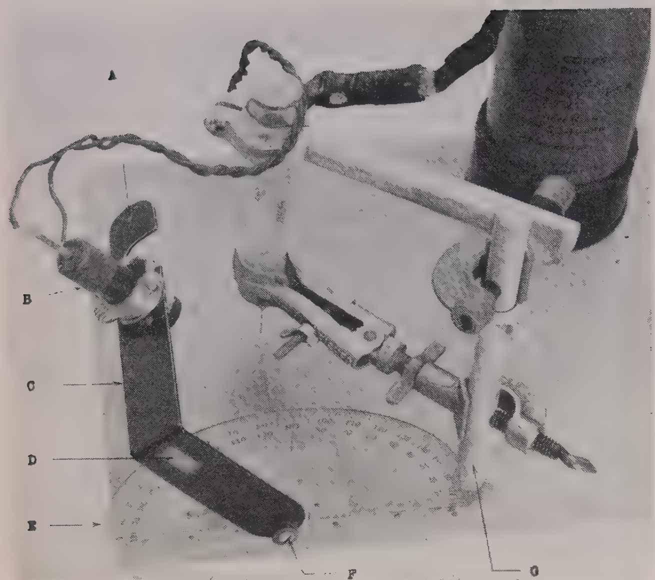



Fig. 8.—Apparatus for Measuring Contact Angles.

A—Peephole for eye, horizontal part right-angle strip. B—Flashlight. C—Right-angle strip. D—Window with pointer in vertical part of right-angle strip. E—Protractor. F—Roundhead wood screw with washer and coiled tension spring. G—Steel post.

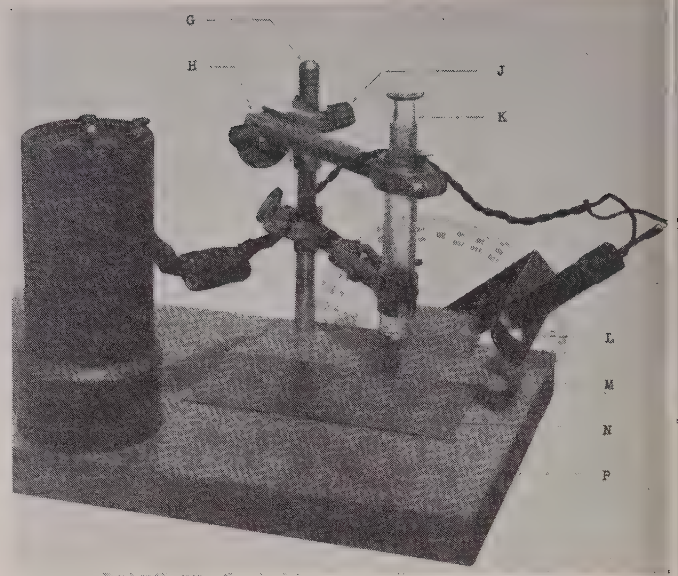



Fig. 9.—Apparatus for Measuring Contact Angles.

G—Steel post. H—Clamp arm for holding syringe. J—2-way clamp. K—Hypodermic syringe with needle. L—Clearance cut for hypodermic syringe. M—Wood block for mounting right-angle strip. N—Steel test panel in position. P—Wood base, approx. 9 in. wide by 12 in. by 1 in. thick.

The 6-in. diameter protractor $E$ is fastened to the edge of base $P$ and the side of block $M$. The center of the base of the protractor $E$ is cut away and the screw $F$ screwed into block $M$. Strip $C$ rotates at $F$ with tension obtained by means of a small spring.

The $1\frac{1}{2}$-v battery and resistor connected to the flashlight $B$ are not essential, but were found convenient due to the short life of the small flashlight battery. The large battery might interfere with the placement of larger panels on the base $P$ than the 3 by 6-in. panel $N$ shown in Fig. 9.

The procedure is as follows: With the tip of the hypodermic needle 5 mm above the panel surface, a drop of water (approximately 0.01 ml) is dropped on the panel by gentle pressure on the plunger. The test is performed preferably in a semidark room. When the flashlight is turned on, the starlike reflection from the drop is noted through the peephole with the angle of the L-strip between 70 and 90 deg. Keeping this reflection in view, the metal strip is moved toward a more acute angle until the reflection disappears. The angle at which the reflection disappears is then read from the protractor, the angle between the vertical and the hairline being the contact angle. The incident and reflected light is shown diagrammatically in Fig. 10.

Additional work[7] on comparsion of the Rock Island Arsenal drop test, the contact angle method, and the modified Mears test has given further evidence of the usefulness of the drop test and the contact angle test as methods for testing for the cleanliness of steel test panels.

Panels were cleaned by the solvent spray method with and without treatment with 1:1 phosphoric acid and by the trichlorethylene vapor degreasing method with and without treatment with 1:1 phosphoric acid. Panels were soiled by a different procedure than used in the preceding tests. The panels were laid on a rack in a horizontal plane and the soiling solution was flowed on the panel with a 1-ml pipet. The soil solutions consisted of redistilled naphtha containing 0.00005, 0.0001, 0.00025, and 0.0005 ml of oil per ml of naphtha.

It was shown that both the contact angle method and the drop test would definitely detect 0.0001 ml of oil per 100 sq cm of surface. It is also possible that the contact angle would detect 0.00005 ml of oil per 100 sq cm of surface. Tests on clean panels using the Rock Island Arsenal drop method gave drops of 20 to 22 mm diameter, the contact angle gave readings of 39 to 49 deg, and the modified Mears test 13 to 41 sec. The modified Mears test (activity test) did not distinguish between clean panels and the soiled panels, but did show higher readings on the clean panels which were treated with phosphoric acid than on those clean panels which were not treated with phosphoric acid with readings of 31 to 41 on the former and 13 to 20 on the latter. Some representative results are shown in Table III.

Although the last revision of D 609 retains the dip water-break test, the adequacy of this test has been questioned. The Rock Island Arsenal drop test and the contact angle test have both been shown to be effective for determining the cleanliness of a steel surface such as that of a D 609 test panel. As stated above, the activity test does not appear to be a useful test for soiled panel surfaces.

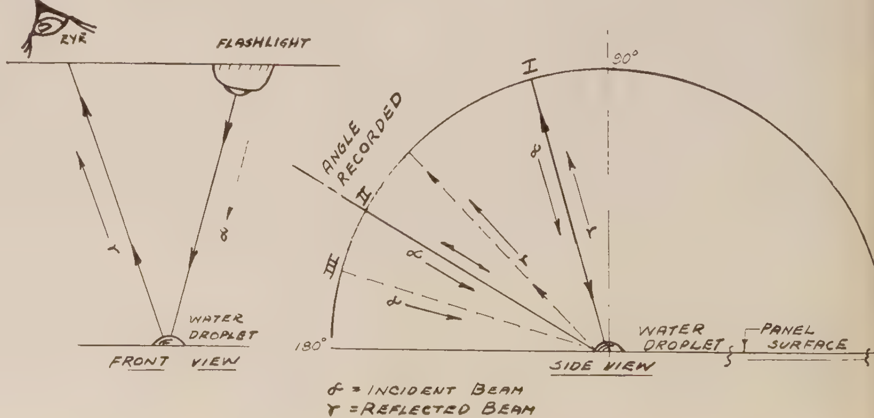



Fig. 10.—Incident and Reflected Light.
I—Angle Less Than Contact, Angle II—Contact Angle, III—Angle Greater Than Contact Angle.

# Evaluation of Strippable Protective Coatings for Acrylic Plastics[1]

By Howard G. Pfleiderer[2] and Roy A. Machlowitz[2]

Synopsis

The work reported in this paper was performed to provide a basis for a specification covering spray-applied strippable protective coatings for formed acrylic plastic parts. Tests were devised to evaluate the following properties of the protective coating materials: sprayability, "delivery rate" viscosity, effect on stressed plastics, usability in normal shop operations, stacking under load, adhesion, tensile strength, ultimate elongation, strippability after weathering, protection of stressed and unstressed plastic from paint materials, and storage stability. Test results on one satisfactory material are given to illustrate the test methods.

Clear acrylic plastics have replaced glass in a number of important uses on military aircraft, such as cockpit canopies and windshields. One of the principal drawbacks to the use of the relatively soft plastics, however, has been the ease with which they incur scratches and are attacked by solvents during routine storage, handling, fabrication, and maintenance processes. To protect the plastics during such operations, and thereby maintain the desired optical properties, protective materials are often applied to both flat and formed acrylic plastics before such operations. These protective materials must be of the kind that may be removed readily after they are no longer required. Pressure-sensitive adhesive-coated paper, frequently used to protect flat sheets of acrylic plastics, is not suitable for such use because of its permeability to the solvents encountered in cleaning and painting operations and because of the difficulty encountered in its removal after long periods of storage. The use of spray-applied strippable protective coatings, which do not have these limitations, on formed acrylic plastic parts, as well as on flat sheets, has become quite common. The military services, as the principal users of plastic cockpit canopies, are among the largest purchasers of such protective coatings. Governmental policy requires that procurement of materials, wherever possible, be based on specifications. The work reported in this paper was performed to provide the basis of a specification covering spray-applied strippable protective coatings for formed acrylic plastics. Not all of the test methods discussed herein were included in the specification.[3] The routine tests of the specification, such as nonvolatile content, are not discussed because they are standard procedures.

The general procedure followed in preparing a specification of this type has been discussed in a previous paper,[4] and its shortcomings were noted at that time. In this instance, eleven samples of protective coating materials were received from seven manufacturers for evaluation by the Aeronautical Materials Laboratory. Only one of the materials proved at all suitable, so the specification requirements were, of necessity, based on that one material. The test results obtained on that one material are presented in Table I to illustrate the test methods. Field reports indicate that that material has been satisfactory in service use.

The samples received were subjected to tests based on the properties considered desirable in such protective coatings. These properties were grouped under six headings: (1) application, (2) effect on stressed plastics, (3) usability in normal shop operations, (4) adhesion and strippability, (5) protection, and (6) storage stability. The tests used to evaluate the samples of protective coatings in terms of these properties are discussed below.

*Application:*

The protective coating should be easy to apply in the required thickness, even on vertical surfaces, in the form of smooth films. The following test procedure was used to determine the sprayability of the coatings. A DeVilbiss MBC spray gun, with a Type FF fluid tip and needle and a No. 765 air cap was used at 55 to 75 psi line pressure and 16 psi cup pressure. The gun, with the fluid nozzle at maximum opening, was moved in a path 6 to 10 in. from the vertical polymethyl methacrylate panel and one cross-pass applied. This produced a coating approximately 3 mils thick. The coating was examined for sagging.

Since many of the protective coating materials are thixotropic, the commonly used efflux-type viscosity determinations are not meaningful. The following service-simulating "viscosity" test was devised to measure this property: the coating material was sprayed with the gun and settings described above, into a large graduated cylinder for exactly 1 min. Based on the sprayed-panel test, a delivery rate of 250 to 350 ml per min was considered satisfactory.

*Effect on Stressed Plastics:*

Formed polymethyl methacrylate parts, such as cockpit canopies, are less resistant to "craze" than flat panels because of residual stresses resulting from the forming operation. The following test was used to ascertain whether the protective coating materials could be safely used on formed plastics: three "craze"-free panels 1.00 by 7.00 by 0.250 in. were set up as in Method 3053 of Federal Specification L-P-406a, as cantilever beams with the fulcrum 2 in. from the clamped end and loaded at the free end 4 in. from the fulcrum to a stress of 3500 psi. (The required load was computed from the formula

$$P = \frac{Sbd^2}{6L}$$

where:

$P$ = load in pounds,
$S$ = stress in psi.
$b$ = width in inches,
$d$ = thickness in inches, and
$L$ = distance from fulcrum to load in inches.

Previous work had shown that 3500 psi was the maximum stress polymethyl methacrylate could withstand without "crazing" within 24 hr, so the test condition represented the most severe possible condition.) After the panel had been under load for 10 min, the coating material was applied (to a dry film thickness of approximately 3 mil)

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] The opinions expressed in this paper are those of the authors and not necessarily official opinions of the Naval Air Experimental Station or the Navy Department.

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[3] Military Specification MIL-C-6799A, "Coating, Protective (for Formed Acrylic Base Plastic)," issued February 2, 1951.

[4] Roy A. Machlowitz, "Evaluation of Polishes for Use on Aluminum Aircraft Surfaces," ASTM Bulletin, No. 156, January, 1949, p. 46.

TABLE I.—TEST RESULTS OBTAINED WITH A SATISFACTORY STRIPPABLE PROTECTIVE COATING[a] FOR ACRYLIC PLASTIC.

| Test Methods | Unit of Measurement | Test Results | Test Results after Storage-Stability Test (Where Applicable) |
|---|---|---|---|
| | APPLICATION | | |
| Appearance | Visual | No sagging | ........ |
| Viscosity | Ml per minute | 300 | ........ |
| | EFFECT ON STRESSED PLASTICS | | |
| | Visual | No "craze" | ........ |
| | USABILITY IN NORMAL SHOP OPERATIONS | | |
| Machining | Visual | No loss of adhesion after 3 hr drying | ........ |
| Stacking under load | Visual | No sticking | ........ |
| | ADHESION AND STRIPPABILITY | | |
| Initial adhesion | Oz per in. width | Range 13.0 to 16.6<br>Avg, 15.7 | Range, 11.6 to 14.2<br>Avg, 13.5 |
| *Adhesion After Exposure in Fade-Ometer:* | | | |
| 25 hr | Oz per in. width | Range, 26.2 to 42.2<br>Avg, 32.4 | ........ |
| 50 hr | Oz per in. width | Range, 32.6 to 43.6<br>Avg, 36.1 | ........ |
| 75 hr | Oz per in. width | Range, 39.6 to 48.0<br>Avg, 45.1 | ........ |
| 100 hr | Oz per in. width | Range, 28.4 to 49.0<br>Avg, 39.5 | Range, 41.8 to 52.4<br>Avg, 47.3 |
| 125 hr | Oz per in. width | Could not be stripped | ........ |
| *Adhesion after Exposure to High Humidity:* | | | |
| 24 hr | Oz per in. width | Range, 15.0 to 19.0<br>Avg, 16.6 | Range, 24.2 to 28.2<br>Avg, 26.2 |
| 48 hr | Oz per in. width | Range, 14.2 to 23.4<br>Avg, 21.2 | ........ |
| *Adhesion after Exposure to High Humidity:* | | | |
| 72 hr | Oz per in. width | Range, 17.2 to 24.0<br>Avg, 20.2 | ........ |
| *Tensile Strength, Initial:* | Psi | Range, 2050 to 2600<br>Avg, 2290 | Range, 1615 to 2250<br>Avg, 2000 |
| | Oz per in. width | Range, 180 to 212<br>Avg, 200 | Range, 168 to 234<br>Avg, 198 |
| After 100 hr in Fade-Ometer | Psi | Range, 874 to 1187<br>Avg, 1000 | ........ |
| | Oz per in. width | Range, 98 to 122<br>Avg, 108 | ........ |
| After 24 hr in humidity cabinet | Psi | Range, 2250 to 2824<br>Avg, 2545 | ........ |
| | Oz per in. width | Range, 217 to 264<br>Avg, 245 | ........ |
| *Ultimate Elongation, Initial:* | Per cent | Range, 220 to 240<br>Avg, 230 | Range, 220 to 245<br>Avg, 233 |
| After 100 hr in Fade-Ometer | Per cent | Range, 220 to 230<br>Avg, 222 | ........ |
| After 24 hr in humidity cabinet | Per cent | Range, 260 to 280<br>Avg, 270 | ........ |
| *Strippability after Accelerated Weathering:* | | | |
| 3-mil film thickness | Number of cycles until no longer strippable | 10 | ........ |
| 6-mil film thickness | Number of cycles until no longer strippable | 24 | ........ |
| 9-mil film thickness | ........ | More than 28 | ........ |
| | PROTECTION | | |
| *Unstressed panels:* | Visual | | |
| Primer | .......... | Strippable, no attack | |
| Lacquer | .......... | Strippable, no attack | |
| Enamel | .......... | Strippable, no attack | |
| Barrier material | .......... | Strippable, no attack | |
| *Stressed panels (2000 psi)* | Visual | | |
| Primer: | | | |
| 3-mil film thickness | .......... | Slight "craze" | |
| 6-mil film thickness | .......... | No "craze" | |
| 9-mil film thickness | .......... | No "craze" | |
| Lacquer: | | | |
| 3-mil film thickness | .......... | Severe "craze" | |
| 6-mil film thickness | .......... | No "craze" | |
| 9-mil film thickness | .......... | No "craze" | |
| Enamel: | | | |
| 3-mil film thickness | .......... | No "craze" | |
| 6-mil film thickness | .......... | No "craze" | |
| 9-mil film thickness | .......... | No "craze" | |
| AN-C-145 Material: | | | |
| 3-mil film thickness | .......... | Severe "craze" | |
| 6-mil film thickness | .......... | Slight "craze" | |
| 9-mil film thickness | .......... | No "craze" | |
| *Stressed plastics (3500 psi)* | Visual | ........ | |
| Primer: | | | |
| 3-mil film thickness | .......... | Severe "craze" | |
| 6-mil film thickness | .......... | Slight "craze" | |
| 9-mil film thickness | .......... | No "craze" | |
| Lacquer: | | | |
| 3-mil film thickness | .......... | Severe "craze" | |
| 6-mil film thickness | .......... | Severe "craze" | |
| 9-mil film thickness | .......... | No "craze" | |
| Enamel: | | | |
| 3-mil film thickness | .......... | No "craze" | |
| 6-mil film thickness | .......... | No "craze" | |
| 9-mil film thickness | .......... | No "craze" | |
| AN-C-145 Material: | | | |
| 3-mil film thickness | .......... | Severe "craze" | |
| 6-mil film thickness | .......... | Slight "craze" | |
| 9-mil film thickness | .......... | No "craze" | |
| | STORAGE STABILITY | | |
| | Visual | Satisfactory (see last column) | |

[a] All film thicknesses in this table refer to the thickness of the strippable coating.

to the tension side of the beams and permitted to dry until strippable (30 to 90 min), with the panel kept under load. After the coating was removed, the panel, still under load, was examined for "craze" with the aid of a strong light. Uncoated panels, which had been kept under load for the duration of this test procedure, were also examined as controls.

*Usability in Normal Shop Operations:*

One of the important properties required of the protective coatings is that they permit performance of the common machining operations while affording the desired protection from scratches. It should be possible, for practical production reasons, to conduct these operations as soon as possible after application of the coating. The following test procedure was used to determine simultaneously, whether the coating would adhere to the plastic during machining operations and how long the coating had to dry before reaching that condition: Eight panels, 4 by 8 by $\frac{1}{4}$ in., were coated with 3 ± 1 mil films (as measured when dry, by micrometer) of the protective coatings. Pairs of panels which had dried at 70 F (21 C), 65 per cent relative humidity for 1, 2, 3, and 4 hr, respectively, were subjected to the following machine operations, with standard shop equipment and practices being used: each panel was sawed into four equal pieces, one of which was sanded on all edges, the second drilled with a $\frac{1}{8}$-in. drill, the third drilled with a $\frac{1}{4}$-in. drill, and the fourth routed ($\frac{1}{8}$-in. deep, $\frac{1}{8}$-in. wide groove). The holes were drilled so that the test piece contained four holes with $\frac{3}{4}$-in. between edges and three sets of two holes each with $\frac{1}{8}$ in. between edges of a pair and 1 in. between edges of the sets. The panels were examined for evidence of the coating's pulling away from the plastic. It was found that a minimum of 3 hr drying was required before the coating would continue to adhere to the plastic under these conditions.

It is obvious that the use of a protective coating should not introduce new handling difficulties. Both formed plastic parts and the flat sheets are usually stored in stacks. To determine whether the coating would cause the parts to stick together under the load of a stack of parts or sheets, the following accelerated stack-storage test, similar in principle to ASTM Standard Method for Estimating Blocking of Plastic Sheets (D 884 – 48)[5] was devised: two $2\frac{1}{2}$ by 4 by $\frac{1}{8}$-in. panels were coated with 3-mil films and dried for 24 hr. The coated surfaces were dusted with talc, which

[5] 1949 Book of ASTM Standards, Part 6, p. 611.

had been found most suitable for the purpose, and the two panels placed so the coated faces were in contact. The panels were stored under a 40-lb load in an oven at 150 F (65.6 C) for 48 hr. The panels were then cooled at room temperature for 2 hr and separated by hand. No sticking or removal of coating from the panel was observed.

*Adhesion and Strippability:*

The degree of strippability of a strippable protective film is obviously a function of the inter-relationship of two fundamental properties—the adhesion and the cohesive (tensile) strength of the film. It is evident that, for the film to be removable in the large pieces required in practical operations, the cohesive strength of the film must exceed its adhesive force. This factor coupled with the requirement that the film have sufficient adhesion to afford the required protection makes the degree of adhesion a key property of the coatings being discussed. Both the adhesion and the cohesive strength of these coatings are affected by the conditions to which the coated parts may be exposed. The following series of tests were conducted, both initially and after various types of exposure, to measure the adhesion and the cohesive strength of the protective coating films as a means of establishing the existing inter-relationship and its effect on the usability of the film.

*Initial Adhesion.*—Five 6 by $1\frac{1}{2}$ by $\frac{1}{8}$-in. panels were coated with 3-mil films of the protective coating materials, which were then permitted to air-dry for 24 hr. A centrally located 1-in. wide strip of coating was cut the length of the panel. Approximately 1 in. of the film was loosened from the panel and a leader attached. The panel was then clamped in one jaw of a 20-lb capacity pendulum type testing machine and the free end of the leader pulled back 180 deg and clamped in the other jaw. The jaws were separated at a rate of 2 in. per min. The load required to separate the film from the panel was recorded in ounces per inch of width.

*Adhesion after Exposure in the Fade-Ometer.*—Twenty-five panels coated and dried as described above were placed 15 in. from the 13-amp carbon arc enclosed in a Corex D globe of a Fade-Ometer. Groups of five panels each were withdrawn after 25, 50, 75, 100, and 125 hr exposure and the adhesion determined by the method described above.

*Adhesion after Exposure to High Humidity.*—Fifteen panels coated and dried as described above were placed in a humidity cabinet having conditions of 120 F (49 C) and 95 per cent relative humidity. Groups of five panels were withdrawn after 24, 48, and 72 hr exposure. The panels were kept at room conditions for 24 hr and the adhesion determined by the method described above.

*Tensile Strength and Ultimate Elongation.*—Six-mil films were sprayed on metal panels, air-dried 24 hr and then dried an additional 24 hr at 120 F (49 C). The additional drying period was used to make certain that the test films were completely dry. (Six-mil rather than 3-mil films were used because preliminary tests showed that the 3-mil films stretched beyond the maximum jaw travel of the available test equipment.) Five dumbbell specimens were cut and their thickness measured in accordance with Federal Specification ZZ-R-601a. These specimens were conditioned 4 hr at 70 F, 65 per cent relative humidity before being tested. Similar specimens were cut from a film which had been subjected to 100 hr exposure in the Fade-Ometer and another film which had been kept in the humidity cabinet for 24 hr. The tests were conducted on a pendulum-type machine with a 12 in. per min rate of jaw separation. The tensile strength (in psi and ounces per inch of width) and the ultimate elongation (in per cent) were recorded. Ultimate elongation is of interest because a film which had too great an elongation would continue to stretch rather than peel off while being stripped. Considerable elongation is, however, required for the film to have the required flexibility.

*Strippability after Accelerated Weathering.*—Strippable films often become difficult to remove after being exposed to the weather as a result of embrittlement or increased adhesion. The effect of weathering on protective coating films of various thicknesses was studied with the use of the accelerated weathering cycle procedure described in Method 6021 of Federal Specification L-P-406a, which is similar to ASTM D 795 – 49 Recommended Practice for Accelerated Weathering of Plastics using S-1 Bulb and Fog Chamber (D 795 – 49).[6] The basic 24-hr weathering cycle consists of 2 hr exposure to a mist fog, 2 hr artificial sunshine, 2 hr mist fog, and then 18 hr artificial sunshine. Panels, 4 by 4 by $^1/_8$ in., were coated with 3-, 6-, and 9-mil films, dried 24 hr at room temperature and then subjected to the weathering cycles. At the end of each 24-hr cycle, one panel of each film thickness was removed and cooled for 2 hr at room temperature, and then the film was stripped by hand. The number of 24-hr cycles used before the film could no longer be stripped was recorded and is shown in Table I.

[6] 1949 Book of ASTM Standards, Part 6, p. 705.

*Protection:*

One of the principal uses of strippable protective coatings is to protect acrylic plastic parts from overspray while other portions of the aircraft are being painted. To simulate this use, the following test procedures were employed:

*Unstressed Panels.*—Panels 4 by 4 by $^1/_8$ in., were coated with 3-, 6-, and 9-mil films of the protective coating and air-dried 24 hr at room temperature. One of each of these panels was sprayed with a wet film (representing the worst possible type of overspray) of Air Force - Navy Aeronautical Specification AN-P-656 zinc chromate primer, ANA Specification AN-L-29 cellulose nitrate lacquer, ANA Specification AN-E-3 enamel, and ANA Specification AN-C-145 material. The paint materials were all thinned in accordance with standard practice using, respectively, Federal Specification TT-T-548 Toluene; ANA Specification AN-TT-T-256, am. 7, Thinner; Cellulose Nitrate Dope and Lacquer (an ester base material); ANA Specification AN-VV-N-96, am. 4, Naphtha, Petroleum; aromatic and methyl ethyl ketone. Twenty-four hours after the paints had been applied, the overcoated strippable films were removed and the panels examined for "craze" resulting from solvent attack. If the strippability of the film had been adversely affected, that fact was noted.

*Stressed Panels.*—One by 7 by $^1/_4$ in. panels were coated with 3-, 6-, and 9-mil films of protective coating and air dried 24 hr at room temperature. The coated panels were then set up as cantilever beams in the manner previously described and loaded to maximum fiber stress of 2000 psi (representing the normal maximum residual stress) and 3500 psi (representing the maximum stress which would not cause "crazing" within 24 hr). Three panels under each condition were coated with each of the paint materials named above. Twenty-four hours later, the overcoated strippable films were removed and the panels examined for "craze" resulting from solvent attack. The degree of "craze" was rated "none," "slight," "moderate," or "severe."

*Storage Stability:*

The materials must be capable of withstanding storage, prior to use, under a wide range of temperatures. The following cyclic exposure test was used to evaluate this property: one gallon of material in a full container as supplied by the manufacturer was subjected to the following sequence: 120 hr at 30 F (−1 C), 24 hr at 77 F (25 C), 100 hr at 0 F (−18 C), 24 hr at 77 F (25 C), 240 hr at 150 F (66 C), 24 hr at 77 F (25 C).

At the conclusion of this cycle, the material was used to prepare films for the tests for initial adhesion, adhesion after 100 hr in the Fade-Ometer, adhesion after 24 hr in the humidity cabinet, tensile strength and ultimate elongation. These tests were conducted to determine whether the storage-stability-test cycle had adversely affected the properties of the coating material.

### Discussion of Results

While it would have been informative to have subjected all the materials received to all of the tests described herein, tests of a material were, for reasons of economy, discontinued as soon as a material failed in one of the tests. Most of the failures occurred in the tests for application and the protection of unstressed panels. The one satisfactory material was markedly superior in these respects, as may be inferred from the table of test results. The most significant tests are those for protection of stressed panels, strippability after accelerated weathering, and storage stability. These tests have deliberately been made very severe, far more severe than similar tests for comparable materials. The protection tests showed that for complete protection from lacquer solvents a 9-mil film thickness is required. This 9-mil film thickness also proved most resistant to adverse effects in the accelerated-weathering tests. This film thickness has, therefore, been recommended for use where outdoor storage or protection from painting is the intended use, while thinner films may be used for less demanding requirements.

### Conclusions

The test methods discussed herein were devised and utilized to prepare a specification which would provide objective means of evaluating spray-applied strippable protective coatings for acrylic plastics, both as flat sheets and as formed parts. The specification, based on this work, is exclusively a performance type specification and does not restrict manufacturers in formulation, as would be the case with a formulation-type specification. Since one commercially available material did comply with the requirements now incorporated therein, the specification is known to be practical. Other manufacturers should be able to produce materials meeting the specification requirements.

*Acknowledgment:*

The authors wish to acknowledge the contributions of L. I. Meisel, of the Aeronautical Materials Laboratory, in the preparation of this paper.

# A "Color Index" for Floor Tile Resins

By B. A. Reeves[1]

The color of resins and other binder components used in floor tile formulation is important because it affects the color of the finished tile. The use of the coal-tar resin color number system (1)[2] for evaluating this property is well established in the industry. It serves the purpose adequately but is difficult to judge by visual methods, and, since much personal judgment is involved, disagreements frequently occur. A suitable instrumental method which will eliminate personal judgment is needed. The method should be simple to operate and require relatively inexpensive equipment so as to be available to laboratories not normally equipped with the more complicated and expensive photoelectric spectrophotometers.

### Coal-tar Resin Color Number Method

The coal-tar color number test consists in matching the luminous density of a benzene solution of the resin sample at specified concentration with one of a set of standard colored solutions, ignoring any difference in chromaticity between the sample solution and the standard. The standards are acidified water solutions of iron and cobalt chloride, each solution specified as to concentration and designated by numbers running from $\frac{1}{8}$ to 10. Resins darker than 10 are tested at greater dilution, the color being indicated by adding 10 to the determined color number, so that the effective numbers range to 20. The comparison is made visually with the solutions in 1-oz sq bottles.

A substantial difference in hue makes matching the luminous density of the sample with that of the standard difficult. This difficulty often leads to different rating of a sample by different observers, the disagreement amounting to as much as $1\frac{1}{2}$ color numbers. This is a substantial discrepancy, since the specifications for many resins allow only a range of 2 color numbers. There appears to be a tendency, probably not intentional, for the manufacturer to upgrade the color numbers and for the user to downgrade the color numbers of floor tile resins. Typical test results on a number of resins are shown in Table I.

### Proposed Test Method

Many methods (2, 3, 4, 5, 6, 7, 8) for instrumental determination of color numbers have been proposed. None seems entirely suited to this particular problem, and some require the use of a photoelectric spectrophotometer, an expensive and complicated instrument better suited to research than to control use. Accordingly, a method has been devised which is rapid and simple and requires only the use of a relatively inexpensive instrument.

The instrument used in this method is the Luximeter, a photoelectric photometer made by General Electric Co. A steady, 6-v power source is required which may be a storage battery or a constant voltage transformer. The device contains an incandescent light source controlled by a rheostat, a test tube to hold the sample, and a barrier-layer type photocell connected to a microammeter with scale graduated from 0 to 100. The spectral sensitivity of the photocell, supplied by the manufacturer, is shown in Fig. 1.

In use, the indicator is set at 100 by adjusting the rheostat with water in the sample tube. Then when the colored sample is placed in the tube, the microammeter indicates transmittance relative to water. It was found that the rheostat was so sensitive that it was very difficult to adjust properly. This condition was improved by shunting a fixed resistor across the rheostat, an IRC Type BW resistor rated at 2 w, 3.9 ohms being used.

The instrument is calibrated by testing a complete set of freshly made coal-tar resin color solutions (1). The readings are plotted against color numbers to establish a calibration curve. To de-

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Senior Chemist, Control Laboratory, Johns-Manville Corp., Manville, N. J.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

termine the color number of a resin sample, the Luximeter reading is taken on the solution of 2 g in 25 ml of benzene, and the color number is read from the calibration curve. While it is possible to determine the color with a precision of ±0.1 number, it is customary to report readings to the nearest ½ number for resins darker than No. 1. A typical calibration curve is shown in Fig. 2. Each instrument should be individually calibrated before use.

For resins with a color lighter than No. 1, the Luximeter is not entirely satisfactory because the readings come in the constricted part of the scale. This difficulty can be avoided by using a sample concentration of 10 g in 25 ml of benzene and dividing the determined color number by 5. This device is not particularly necessary, because colors lighter than No. 1 can be readily determined visually since the chromaticities of the resin solutions and the standards match well in this range. It is, however, necessary to include the portion of the calibration curve between 0 and 1 because this is used also for colors between 10 and 11.

A number of precautions must be observed in order to insure satisfactory performance. The important ones are as follows:

1. Tight electrical connections are necessary, as a very slight change in voltage changes the reading substantially.

2. The current should be switched on at least 10 min before the instrument is used, as the reading changes during the warm-up period.

3. It is essential to use clean sample tubes. A finger print will cause significant error.

4. Pure water—preferably double distilled—should be used in calibrating the instrument. An unnoticed turbidity will register on the instrument.

5. The meter reading should be adjusted to 100 immediately before testing a sample and checked for drift immedi-

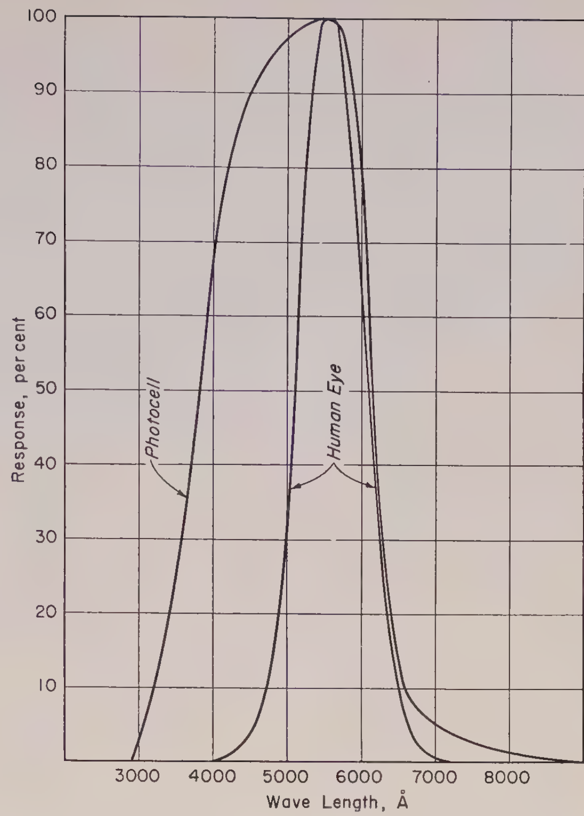


**Fig. 1.—Spectral Sensitivity of Photocell, Showing Relationship Between Cell Response and Human Eye.**

TABLE I.—COLOR TESTS ON PARACOUMARONE-INDENE RESINS OF SEVERAL GRADES FROM VARIOUS MANUFACTURERS ARE SHOWN.

| | Coal-Tar Resin Color Test | | |
|---|---|---|---|
| | Manufacturer—Visual | User | |
| | | Visual | Instrumental |
| Resin I (Cumar T-5-3) Specified range, 2 to 4 | 2 | 3 | 2.8 |
| | 2.5 | 3.5 | 3.5 |
| | 3 | 4.5 | 4.5 |
| | 3 | 4 5 | 4 2 |
| | 2.5 | 4 | 4.0 |
| | 2.5 | 3 | 3.2 |
| | 3.5 | 4.5 | 5.7 |
| | 3 | 3.5 | 4.2 |
| | 3.5 | 4 | 4.5 |
| | 2.5 | 4 | 3.5 |
| | 2.5 | 3.5 | 4.0 |
| | 3 | 3 | 4.0 |
| | 3 | 4 | 4.2 |
| | 3 | 3.5 | 3.7 |
| Resin II (Cumar T-6) Specified range, 2 to 4 | 3.5 | 4 | 3.5 |
| | 7 | 7 | 7.8 |
| | 3.5 | 4.5 | 5.0 |
| | 3.5 | 4.5 | 4.4 |
| | 3 | 4.5 | 5.0 |
| Resin III (Cumar T-15) Specified range, 12 to 16 | 13.5 | 16 | 16.0 |
| | 16 | 16 | 16.5 |
| | 13.5 | 14 | 15.5 |
| | 14 | 16 | 15.3 |
| | 14 | 15.5 | 15.0 |
| | 15 | 16 | 15.7 |
| | 13 | 15 | 15.0 |
| | 15 | 16 | 15.7 |
| | 15 | 16.5 | 16.0 |
| | 15 | 14.5 | 15.5 |
| | 14 | 16 | 15.5 |
| | 15 | 15 | 15.3 |
| | 13.5 | 14 | 15.3 |
| | 14 | 16.5 | 16.0 |
| | 13.5 | 14 | 16.0 |
| | 16 | 17.5 | 17.0 |
| Resin IV (Piccoumarone 420T) Specified range, 2 to 4 | 4 | 4.5 | 5.0 |
| | 4 | 5 | 5.5 |
| | 4 | 5 | 4.5 |
| | 4 | 4.5 | 4.2 |
| | 4 | 4 | 4.7 |
| | 4 | 4.5 | 4.7 |
| | 4 | 5 | 5.0 |
| | 7 | 6 | 7.0 |
| Resin V (Piccoumarone XX100A) Specified range, 12 to 16 | 14 | 16 | 16.0 |
| | 16 | 17.5 | 17.8 |
| | 14 | 16 | 15.5 |
| | 13 | 14.5 | 14.2 |
| Resin VI (Paradine No. 2) Specified range, 12 to 16 | 13.5 | 14 | 14.5 |
| | 13.5 | 14.5 | 14.5 |
| Resin VII (Cumar S) Specified range, 0.5 to 2.5 | 1.5 | 3 | 2.7 |
| | 2 | 2.5 | 3.0 |
| | 2 | 2 | 2.0 |
| | 2 | 2 | 2.6 |
| | 2 | 2.5 | 2.5 |
| | 2 | 2 | 2.0 |
| | 2 | 2.5 | 2.0 |
| | 2.5 | 3 | 3.6 |
| Resin VIII (Piccoumarone 480K) Specified range, 3 max. | 3.5 | 4.5 | 4.5 |
| | 3.5 | 4 | 5.0 |
| | 3.5 | 4.5 | 4.4 |
| | 3.5 | 3.5 | 4.3 |

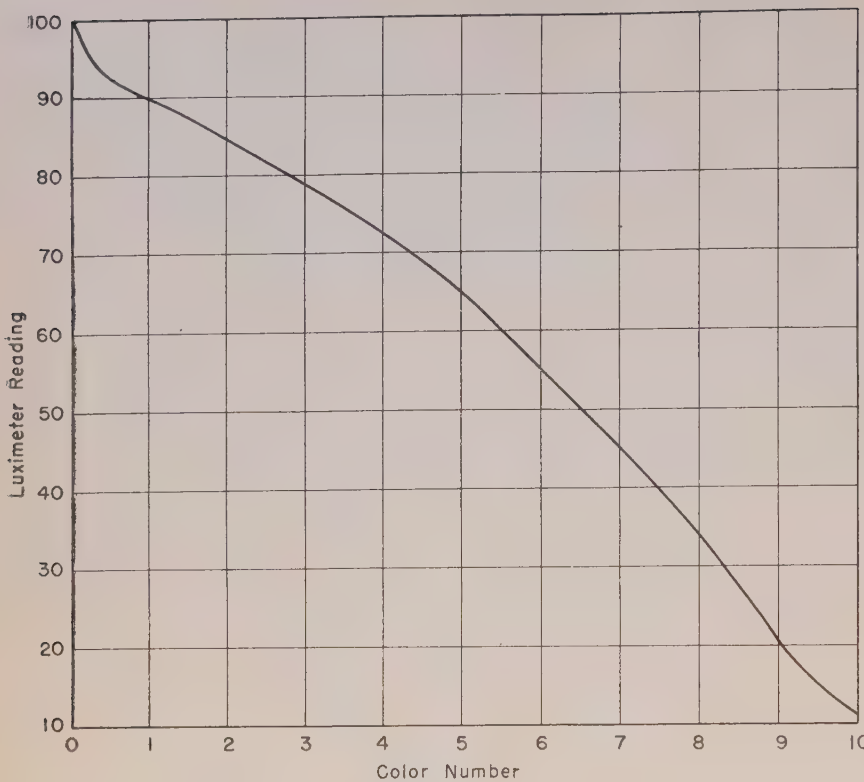


Fig. 2.—Luximeter Calibration Curve.

ately after. The calibration should be checked daily—checking two or three points on the curve is sufficient to show that the instrument is in proper condition and adjustment.

6. The sample tube must be pushed all the way into the slot in order to get the correct reading.

7. The sample tube should be rotated and the average reading recorded.

### Discussion

The coal-tar resin color system differs from that of the ASTM union colorimeter[3] for lubricating oils and from most other color systems in that the luminous density only is considered without regard to the hue. In using the union colorimeter, the hue is matched with the standard and the density is ignored. The coal-tar resin color system makes the assumption that resins having the same luminous density will be sufficiently similar in hue to be satisfactory for manufacturing purposes. Experience to date indicates that this assumption is justified for resins used in floor tile manufacture. This unusual characteristic of the system is what leads to different ratings by different observers and also makes it possible to determine the "color" rating with a simple instrument.

The Luximeter uses a test-tube sample container instead of a rectangular cuvette, with the result that the refractive index of the solution influences the reading. Because of the difference in refractive index between benzene and water, the instrument properly should be zeroed with water when developing the calibration curve data and with benzene when testing a resin sample dissolved in benzene. However, we have found the difference in color rating of resins when zeroing the instrument with these two liquids is usually less than 0.1 number and always less than 0.25 color number. It is therefore not considered necessary to attempt to adapt the instrument for use of a rectangular cuvette or, in control work, to check the calibration of the instrument after zeroing with water and to reset the zero with benzene before testing a sample.

The relationship between the cell response and that of the normal human eye is shown in Fig. 1 (9).

It has been found that the color of floor tile plasticizers can be determined satisfactorily by this method. This simplifies test data interpretation by expressing the color of all binder ingredients in the same units.

### Conclusion

The uncertainties involved in visual rating of floor tile resins and other binder components according to the coal-tar resin color system can be resolved by the use of a photoelectric photometer. A suitable and inexpensive instrument for this purpose is the General Electric Luximeter. Other photoelectric photometers are equally suitable if equipped with the proper filter.

Use of an instrument frequently results in a darker rating than that obtained by visual inspection. The instrumental rating is considered to be more reliable because the average observer cannot separate completely the effects of hue and density.

[3] Tentative Method of Test for Color of Lubricating Oil and Petroleum by Means of ASTM Union Colorimeter (D 155 – 45 T), 1949 Book of ASTM Standards, Part 5, p. 780.

### References

(1) C. S. Reeve, "The Determination of Color of Paracoumarone-Indene Resins," *Paint, Oil, and Chemical Review*, Vol. 105, No. 1, Jan. 14, 1943, p. 16.

(2) S. W. Ferris and J. M. McIlvain, "Optical Density Color Measurement for Petroleum Oils," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 6, p. 23 (1934).

(3) I. M. Diller, J. C. Dean, R. J. DeGray, and J. W. Wilson, "Color Index—Light Colored Petroleum Products," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 15, p. 367 (1943).

(4) I. M. Diller, R. J. DeGray, and J. W. Wilson, "Photoelectric Color—Description and Mensuration of the Color of Petroleum Products," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 14, p. 607 (1942).

(5) R. H. Osborn and W. C. Kenyon, "A General Method of Color Grading," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 18, p. 523 (1946).

(6) B. W. Storey and V. A. Kalichevsky, "Photoelectric Colorimeter for Measuring Color Intensities of Petroleum Products," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 5, p. 214 (1933).

(7) L. Lykken and J. Rae, "Determination of the Relative Color Density of Liquids—A Rapid Photoelectric Method," *Analytical Chemistry*, Vol. 21, p. 787 (1949).

(8) L. K. Whyte, "The Photoelectric Determination of the Color of Certain Glyceride Oils," *Journal*, Am. Oil Chemists' Soc., Vol. 24, p. 137 (1947).

(9) A. C. Hardy, "Handbook of Colorimetry," p. 9, Cambridge Technology Press (1936).

# ASTM Bulletins—1951

## Subject Index Papers, Reports, and Articles*



* Reprints of this Subject and Author Index are available to members on request.

# Index to Authors of Technical Papers

## 1951 ASTM Bulletins

## Advertising References Help Standardization

RECENTLY an important company in the cement field bought a two-page spread in a trade magazine to inform the building industry of the properties of cement made according to a specific ASTM Standard. In another instance a trade association announced in an advertisement in the publication of its field that all of its members manufactured their product in accordance with ASTM specifications. References of this kind in the business press do the cause of ASTM and standardization much important service.

A recent brochure sent to the editor of the BULLETIN exemplifies another type of valuable publicity for ASTM Standards. The two-page bulletin set down considerable engineering information concerning plastic balls for use in valves, valve components, specialized anti-friction bearings, mechanical checks, and other industrial applications. Particularly interesting was the list of properties of the balls given in terms of ASTM Standards.

Thirty-two items appear in the "Property" column of the chart, these being tested by eighteen different ASTM Standards. As an example, one line of the chart read, "Shear Strength...in lb./sq in...D 732–43 T...9,600."

It is our feeling that a piece of literature such as this serves its purpose admirably since by citing a specific ASTM method or specification a manufacturer sets down the properties of his product in as clear and succinct a manner as one could imagine. Such a brochure as this also does ASTM considerable service since it promotes an awareness in industry of the function being performed by our Society.

## Members Discuss Importance of Gasoline Specifications

R. C. ALDEN, of the Phillips Petroleum Co., Bartlesville, Okla., presented a paper on "Gasoline Specifications and Test Methods" at a meeting of the North American Gasoline Tax Assn. in Columbus, Ohio, in October.

A long-time member of ASTM Committee D-2 on Petroleum Products and Lubricants, Mr. Alden pointed out that the establishment and administration of laws relating to highway fuels have many strong repercussions on the development and improvement of automotive fuels, of automotive equipment, and of the related services, noting that not only taxes *per se* but such details as specifications and test methods in gasoline inspection regulations have some influence on the direction and speed of many new developments. He observed that in so far as the tax laws are concerned, in the 19 states where it has been found necessary to have any technical specifications to define taxable gasoline, chief reliance is placed on the ASTM definition for naphtha, which definition is used also by the Bureau of Internal Revenue for the Federal gasoline tax.

Concerning the gasoline inspection laws, he noted that the states are not unanimous as to the need for such regulations, there being no inspection laws in ten states nor in the District of Columbia. In 19 of the 38 states having such laws, the administration of the law is lodged in the same state bureau responsible for administration of the gasoline tax law, indicating that many legislators think there is some connection between a gasoline inspection law (which means specifications) and a tax law (which means definitions or classifications).

After brief reference to the specialized problems of specifications and test methods pertaining also to government gasoline purchases, Mr. Alden gave a résumé of the organization, method of functioning, accomplishments, and publications of Committee D-2, concluding his discussion with an exhaustive review of ASTM D 439 Tentative Specifications for Gasoline, adopted in 1937, and revised in 1940, 1948, 1949, and 1950. He expressed the disappointment of the committee that more use had not been made of these tentative specifications for gasoline, noting that there are several years of work and study substantiating the latest revision in regard to maximum Reid vapor pressure for winter gasolines in the northern states, and urging a reconsideration of their vapor pressure and distillation loss specifications by those concerned with the administration of laws relating to gasoline. Commenting that the D 439 specifications are too detailed to be used in state inspection laws, the seasonal and geographic details being far too complex, he added that with competent technical advice, the general principles involved can be adapted to meet particular situations. He emphasized that technical assistance would be forthcoming for the asking from Committee D-2, and that the committee would welcome more representation from responsible state agencies concerned with highway fuel taxes.

## Nomenclature of Measuring Devices

A RECENT issue of *Science Digest*[1] carried an interesting item relative to the development of the nomenclature of measuring devices, listing in the form of a matching contest a number of the widely used measuring instruments with the dates of their invention. We quote from this source as follows: "During the growth of science in the past three centuries, scientists have developed and coined names for scores of measuring devices. A few of these instruments, such as the voltmeter, galvanometer, am(pere) meter, and Geiger counter, are named for men; but most of the devices are designated by words coined from Greek or Latin nouns plus 'meter' from *metron*, measure, in the former language. Thermometer and barometer, for example, are recorded in the Shorter Oxford English Dictionary as first appearing in print in 1633 and 1665 respectively, being coined from the Greek, *thermos*, heat, and *baros*, weight."

The following 18 measuring instruments were invented in the 17th, 18th, and 19th centuries:

altimeter (1847)......height
anemometer (1727)...velocity of wind
audiometer (1879)....hearing
bathometer (1875.....depth of water
calorimeter (1794)....quantities of heat
goniometer (1766)....angles
heliometer (1753).....distances between stars
hydrometer (1675)....specific gravity
hygrometer (1670)....humidity
macrometer (1825)....remote objects
micrometer (1670)....minute distances
pedometer (1723).....distance covered in walking
perimeter (1875).....field of vision
photometer (1760)....intensity of light
planimeter (1858)....area
pluviometer (1791)...rainfall
spectrometer (1874)...deviation of rays
tachometer (1810)....velocity

[1] *Science Digest*, October, 1951, Match-the-Meters Quiz, E. V. W. Read.

## Tests of Air-Entraining Admixtures

RECENTLY a copy of Technical Memorandum No. 6-327 on "Tests of Air-Entraining Admixtures," published by the Waterways Experiment Station of the Corps of Engineers, was received. This memorandum contains a very concise report on this current subject and gives the results of tests conducted on 75 samples representing 15 brands or types of materials manufactured by 10 different producers. This work was conducted in part on samples submitted by field offices for testing in connection with proposed use on specific projects and on work done on samples obtained from manufacturers. The investigation was performed under the supervision of Herbert K. Cook, Chief, Concrete Research Division, Waterways Experiment Station, and was prepared by E. E. McCoy and Bryant Mather. Copies may be obtained from the Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss., at a cost of 75 cents.

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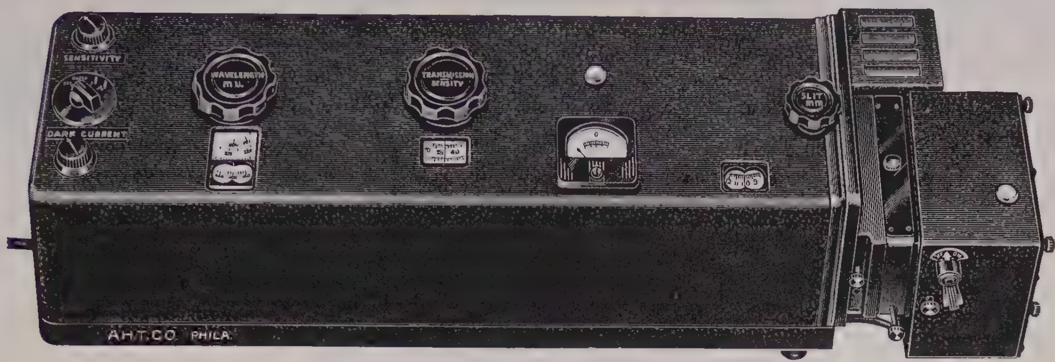


9101-A2.

**QUARTZ SPECTROPHOTOMETER, Beckman Photoelectric.** A self-contained unit with which a wide variety of research and control work can be conducted with convenience, speed and precision. Consisting of a quartz monochromator, with light source, holder for absorption cells, twin phototubes and built-in electronic meter for translating phototube currents into direct readings of percentage transmission and density. See Cary and Beckman, "A Quartz Photoelectric Spectrophotometer," *Journal of the Optical Society of America, Vol. 31, No. 11 (November, 1941), p. 682.*

**Monochromator.** Autocollimating type, with 30° quartz prism of selected crystal which provides high dispersion in the ultra-violet. Wavelength scale approx. 100 cm long, readable and reproducible to 0.1 mmu in the ultra-violet and to 1.0 mmu in the infrared, with a scale accuracy of 1 mmu. Optical parts rigidly mounted in a massive heat-treated iron block within a dust-proof steel case.

**Slits.** Protected by quartz windows, with stray light effects reduced to a minimum. Simultaneously and continuously adjustable from 0.01 to 2.0 mm by a precision mechanism. Slits can not be damaged by closing too far. Full scale reading with nominal band width less than 2 mmu over all but the extreme ends of the spectrum.

**Electronic Indicating Meter.** A built-in potentiometer and electronic amplifier makes possible direct readings in percentage transmission and density. The switch position marked ".1" provides a ten-fold expansion of the transmission scale for more accurate readings on solutions below 10% transmission.

**Light Source.** A standard 32 c. p. 6-volt, tungsten lamp serves as a light source for the range 320 to 1000 mmu. A hydrogen discharge lamp is furnished for use in the ultraviolet range below 320 mmu. *Lamps are mounted on self-aligning, interchangeable backplates in the liquid-cooled, cast metal lamp housing.*

**Sample Holders.** Absorption cells are accommodated in a removable holder which is inserted in a light-tight compartment and is operated from the front of the instrument by means of a sliding rod. Cells and holders are available for 10, 20, 50 and 100 mm liquid lengths.

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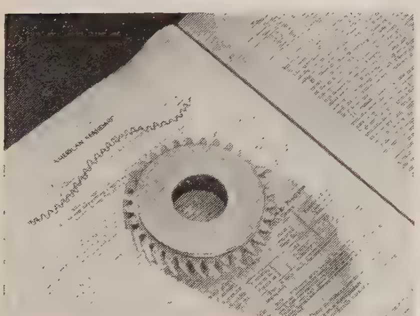

*The new American Standard,* "Inspection of Fine Pitch Gears," recommends the composite gear-check principle. Class 3 tolerance for precision fine pitch gears calls for a tooth-to-tooth composite error no greater than .0002″, a tolerance easily checked with Kodak Conju-Gage Gear Checkers. A copy of this helpful booklet will gladly be sent on request.

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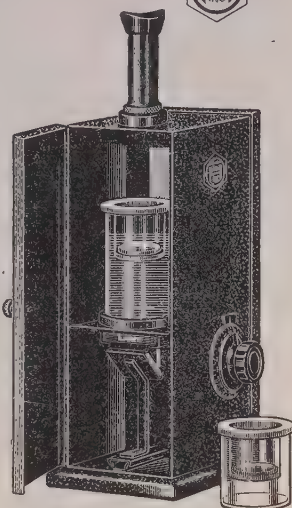







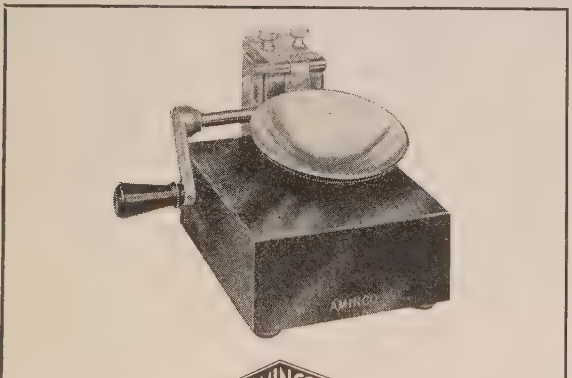

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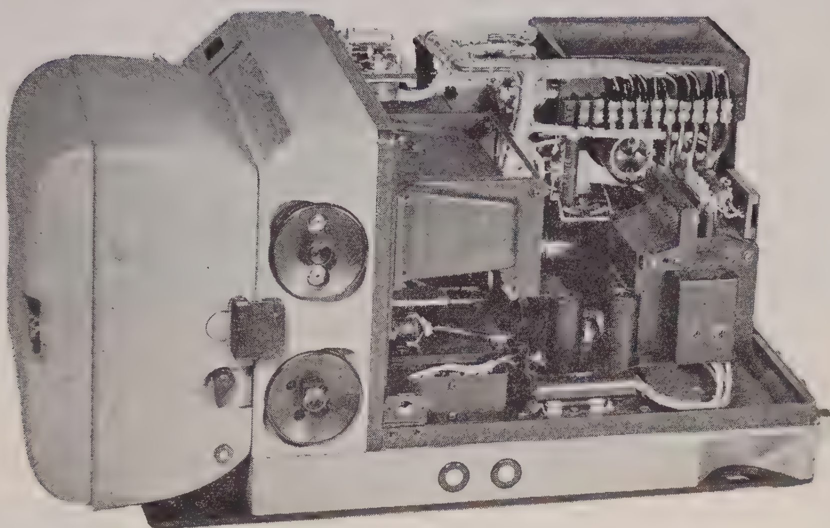

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Consolidated's 5-116 Recording Oscillograph, while costing considerably less than other instruments comparable in precision, construction, and versatility, produces records equal in quality to those of the Consolidated Type 5-114. It lacks only some of the features that may be dispensed with in many recording applications, such as the automatic record length control, visible wave-form scanning, etc. Specific instrumentation problems are welcomed by Consolidated's application engineering section, whose experienced engineers will analyze each problem individually and determine how dynamic instrumentation will answer questions of product design and performance.

**CEC's 5-114** Recording Oscillograph records up to 18 traces simultaneously on 7″-wide paper or film, is designed as the ultimate in precision, versatility, and operating convenience and incorporates many features available only through special accessories on many other oscillographs. Recording speeds from ½″ to 115″ per second and easily removable feed-and-takeup record magazines of 125, 250, and 600-ft. capacity offer an unusually wide application range. Write for Bulletin CEC-1500-X43.


**CEC's 5-116** Recording Oscillograph records up to either 9 or 14 traces on 5″-wide paper or film at recording speeds of ¼″ to 100″ per second. Its removable feed-and-takeup magazine holds 125 feet of recording paper and is designed for the utmost loading and unloading convenience. Write for Bulletin CEC-1521-X18.

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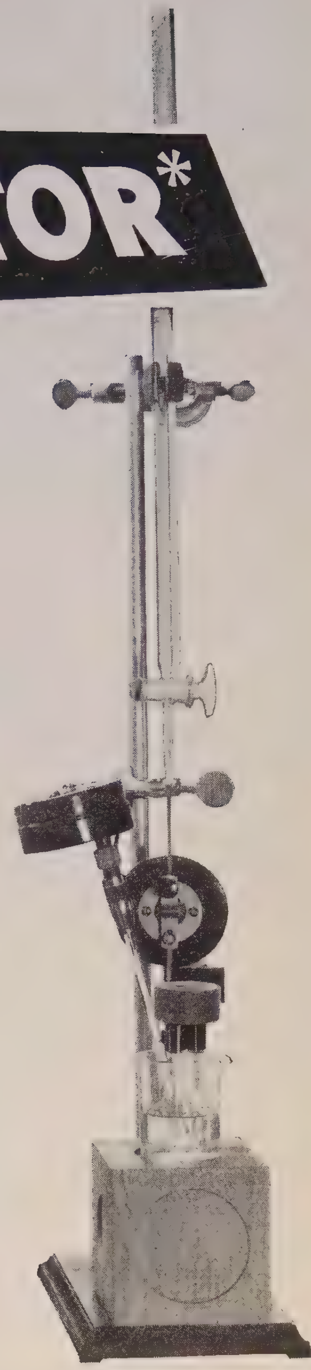



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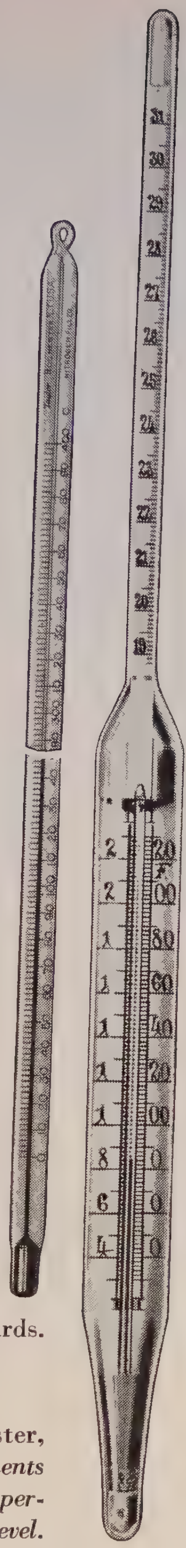



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